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A Manual On: Evaluation And Economic Analysis Of Livestock Waste Management Systems

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The discussion and evaluation of waste management systems are related to the regional concentration of livestock species and to climatic constraints. The economic analysis of alternative waste systems is done for each species separately and considers fertilizer nutrient return as a benefit. Detailed economic analysis of waste management options are provided in the Appendices for each species. All cost data are in 1977 dollars.

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A Manual on:

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by

R. K. White
D. L. Forster
The Ohio Agricultural Research and Development Center
Wooster, Ohio 44691
and
The Ohio State University
Columbus, Ohio 43210

Grant No. R-804548

Project Officer

S. C. Yin
Source Management Branch
Robert S. Kerr Environmental Research Laboratory
Ada, Oklahoma 74820

ROBERT S. KERR ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
ADA, OKLAHOMA 74820

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FOREWORD

The Environmental Protection Agency was established to coordinate administration of the major Federal programs designed to protect the quality of our environment.

An important part of the Agency's endeavors to fulfill its mission involves the search for information about environmental problems, management techniques and new technologies through which optimum use of the nation's land and water resources can be assured. The primary and ultimate goal of these efforts is to protect the nation from the scourge of existing and potential pollution from all sources.

EPA's Office of Research and Development conducts this search through a nationwide network of research facilities.

As one of these facilities, the Robert S. Kerr Environmental Research Laboratory is responsible for the management of programs to: (a) investigate the nature, transport, fate and management of pollutants in groundwater; (b) develop and demonstrate methods for treating wastewaters with soil and other natural systems; (c) develop and demonstrate pollution control technologies for irrigation return flows; (d) develop and demonstrate pollution control technologies for animal production wastes; (e) develop and demonstrate technologies to prevent, control or abate pollution from the petroleum refining and petrochemical industries; and (f) develop and demonstrate technologies to manage pollution resulting from combinations of industrial wastewaters or industrial/municipal wastewaters.

This report is a contribution to the Agency's overall effort in fulfilling its mission to improve and protect the nation's environment for the benefit of the American public.

William C Galegar

William C. Galegar, Director
Robert S. Kerr Environmental
Research Laboratory

ABSTRACT

This manual was developed to describe and evaluate alternative systems and/or technologies currently used to handle wastes from livestock facilities of less than 1000 animal units. The systems are evaluated with regard to controlling water pollution and odor nuisance. An economic analysis of alternative livestock waste management systems for dairy, beef, swine, sheep and poultry facilities is provided. The economic impact of water pollution control technologies is discussed. This manual is intended to be used by environmental planners, regulatory personnel, and livestock producers.

The discussion and evaluation of waste management systems are related to the regional concentration of livestock species. Climatic constraints are considered in evaluating alternative waste systems. The economic analysis of alternative waste systems is done for each species separately.

Each section on dairy, beef, swine, sheep and poultry considers the current waste management options, an economic analysis of the options and an environmental assessment of the options, including acceptable pollution control technologies. The number of waste systems including technologies for controlling runoff and odor nuisance considered are 59 dairy systems, 45 beef systems, 70 swine systems, 35 sheep systems and 35 poultry systems.

The technologies considered for controlling runoff from confined livestock feedlot are: (1) solids settling, detention and wastewater irrigation and (2) solids settling and infiltration of wastewater in grassed areas. Economies of size are more evident with detention/irrigation than with grassed infiltration. Therefore, runoff control using infiltration which is less expensive is more acceptable economically for small producers.

Manure storage capability is evaluated. Where storage is used, plowdown or injection of waste will reduce the potential for odor nuisance and runoff from land spreading. The benefit from lower fertilizer nutrient loss usually offsets the added cost for incorporating the waste in the soil.

Detailed economic analysis of waste management options are provided in the Appendices for each species. All cost data are in 1977 dollars. These data will enable the producer or engineer to cost the waste management system for a particular facility.

This manual was submitted in fulfillment of Grant No. R-804548 by the Ohio Agricultural Research and Development Center under the sponsorship of the U.S. Environmental Protection Agency. The report covered the period July 1, 1976 to June 30, 1977.

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SECTION 1

INTRODUCTION

Society is placing a continuing emphasis on the maintenance or enhancement of the environment. Legislative, administrative, and judicial branches of government are reflecting this public commitment by the laws, implementing regulations, and court rulings which have established an improved environment as a national goal.

Agriculture, like most sectors of the economy, has been principally affected by Public Law 92-500 which established the national goal of eliminating by 1985 "the discharge of pollutants into navigable waters". This Act delineates two origins of pollutants, point and nonpoint sources. Feedlots are identified in the Act as point source category, and the remainder of production agriculture is placed in the nonpoint category.

The United States Environmental Protection Agency (USEPA) implements the point source provisions of the Act through the National Pollutant Discharge Elimination System (NPDES) regulations (Federal Register, March 18, 1976). For concentrated animal feeding operations, the regulations require a permit for all livestock facilities over 1000 animal units with point source discharges of pollutants into navigable waters. An animal unit is one beef animal or equivalent. Facilities with 300 to 1000 animal units require a permit if the feedlot (1) discharges pollutants through a man-made conveyance or (2) discharges pollutants into waters passing through or coming into contact with animals in the confined area. No permit is required for feedlots with less than 300 animal units except for a case-by-case designation where control is needed. The majority of livestock operations in the United States are not required to obtain an NPDES permit.

The objective of this manual is to provide descriptions and economic and environmental assessments of a range of livestock waste management systems for concentrated feeding operations with less than 1000 animal units. Before producers are mandated to change their water pollution control technologies, environmental planners and regulators and the producer need to have an awareness of the available pollution control technologies, an approximation of the economic impacts of these technologies on the livestock business, and an estimate of the environmental impacts of these technologies. The intent of this manual is to provide this information to environmental planners, regulators, and livestock producers.

The range of waste management systems is greatly influenced by climatic conditions. Thus, throughout the manual the regional nature of available technologies is emphasized. In addition, the location of the various livestock species tends to be regional in nature. Due to economic, technical, and historic reasons, most species are concentrated in a few regions rather than spread uniformly throughout the country. Discussion and evaluation of waste management systems is limited to principal areas of production for each livestock species.

USING THE MANUAL

Most users of the manual will be interested in identifying and assessing the waste management alternatives for one or more species in a particular area of the country. It is suggested that Section 4, titled "Regional Aspects of Livestock Production and Waste Management", be read to understand the climatological constraints and regional delineation of livestock production used in the manual. Next, a general discussion of the waste management option selection process found in Chapter 5 should be read. Finally, the reader would turn to the Section(s) dealing with the species of interest where the waste management options and economic assessments are outlined. If more technical or economic detail is desired for a particular waste management system, the user then could turn to the Appendix where the detailed engineering, investment, and annual cost assumptions are tabulated.

Several caveats are in order. First, the manual is not intended to be an engineering design manual for the vast array of waste management systems noted. Those interested in designing specific systems are encouraged to use Cooperative Extension Service materials or engineering design manuals from their state or region. Second, each of the systems described is producer specific with design, investment outlay, and annual costs being unique. Designs, investments and costs are thought to be "representative"; however, environmental planners and agricultural producers who want to analyze alternatives for a particular farm situation will want to do further analysis. Third, producers recognize that the "best" waste management system does not necessarily dictate the "best" livestock system. The feeding and housing components of any livestock system must also be considered as well as the effects of the livestock system on the use of farm resources. For example, a pasture system in the Cornbelt may appear to be the least-cost waste management system, but only casual analysis would demonstrate its inefficiencies in feeding and costly use of productive cropland. Finally, environmental planners and regulators should be cognizant of the macro implications of any waste management system recommendations. This manual presents only the micro impacts to the farm operation. Persuading large numbers of producers to use a "best management" technology such as six month manure storage may produce unexpected results when all producers in one watershed spread the stored manure at the same time preceding a spring storm.

SECTION 2

SUMMARY

Agriculture is in a process of change due to a number of actors in the economic and political process. One set of actors, the farmers, view agriculture as an efficient sector of the economy producing a low cost food supply. Many farmers view agriculture as their historic domain and become defensive when other actors appear on the scene. Another set of actors includes the institutions, citizens groups, and individuals who place environmental quality as an important national goal. They view agriculture as a sector producing environmental degradation which they have an obligation to check. They usually recognize the immense benefits created by agriculture and seek to make these environmental changes without unduly lessening the low cost food supply.

Livestock production has and will continue to be an area of agriculture where these actors meet. Decisions have been and will be made concerning the "proper" methods of livestock production which are economically efficient and environmentally safe. This manual provides information for this decision making process.

First, the analysis delineates the regions of livestock production in the United States. The principal factors used in identifying these regions are temperature, rainfall, moisture evaporation, livestock production patterns, and topographic features. Then the principal regions of production are located for each species - dairy, beef cow-calf, swine breeding, fed swine, ewes and lambs, fed sheep, layers, broilers, and turkeys.

For each species, common waste management systems are described and evaluated. An economic analysis is done for each system. All cost data are in 1977 dollars. Monetary benefits and monetary costs are computed. Also, a qualitative measure of the environmental costs of each system is estimated. This procedure is followed for 59 dairy systems, 45 beef systems, 70 swine systems, 35 sheep systems, and 35 poultry systems.

Several general observations are apparent from the analysis of these 244 systems. First, the farmer is faced with substantial investment in any particular system. If the farmer is asked to change from a present waste management system to another, it is possible that harsh economic results could occur.

The environmentalist and agriculturalist can make recommendations about the "best" waste management system only by closely analyzing individual farm situations. Recommendations should be made by recognizing the existing system and analyzing the monetary costs and benefits as well as the expected environmental improvements resulting from a range of possible changes.

Major changes in a livestock waste management system may be economically ruinous. However, most existing systems can be modified at a relatively low cost to improve environmental quality. These modifications include controlling runoff from exposed lot surfaces, controlling runoff from fields where waste is surface spread, and lessening odor nuisances from the concentrated livestock lot as well as from the field where wastes are spread.

For the producer using a system with exposed lot surfaces, the least costly changes are normally to modify the existing system to control runoff from the lot. The runoff control options available are the detention/irrigation system and the grassed infiltration system. The detention/irrigation system is the more costly alternative for the farmer, but also it improves environmental quality more than does the grass infiltration system. The small producer is at a distinct disadvantage if the detention/irrigation system is to be required. Economies of size are strongly evident with this technology. Thus, the recommended technology may be different for the small producer than the large one.

Producers with manure storage capabilities are well advised to provide for plowdown of surface spread waste or direct injection of the waste into the soil. These processes reduce potential for runoff of wastes into nearby streams and reduce odor nuisances. In addition, more of the fertilizer nutrients from the waste are available to crops. In most cases where storage is already present, these benefits from increased nutrient availability overshadow any added costs of injection or plowdown.

Producers without manure storage may add storage and realize the benefits of soil incorporation. When storage is not available, daily spreading of manure must be used since regular injection or plowdown is not practical due to cropping. Reduction in labor required for daily spreading of manure can offset a major portion of storage costs.

Waste treatment in lagoons combined with wastewater disposal by irrigation are generally effective methods of pollution control. For larger herd sizes, these systems are competitive with other waste management systems.

Those livestock producers building new facilities are well advised to consider the livestock operation as a complete system rather than considering waste disposal as an afterthought. The waste disposal method strongly affects the type of housing, the feeding system, and the profitability of the livestock enterprise.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are relevant to the findings of this study with respect to controlling pollution from non-NPDES livestock facilities:

1. A large number of livestock production technologies are currently available which effectively control water pollution and odor. Of the 244 systems evaluated in this study, the majority limit water pollution and odor nuisance to acceptable levels. However, even the most effective pollution control technology can go awry if good management practices are not followed.

2. Objective measurement of environmental degradation caused by livestock units has not been established. The lack of objective common denominators means that most waste systems must be evaluated qualitatively.

3. Waste management systems are an important cost to most producers. On the other hand, manure is a resource. There are fertilizer nutrient and labor-saving benefits from manure systems which partially and sometimes fully offset these costs. Farmers as well as national planners need to consider both the costs and the benefits before deciding on acceptable systems.

4. Farmer's monetary benefits and costs are important criteria in the selection of a waste management system. However, other important criteria need to be considered. These include the level of pollution control, the impact of the system on the overall performance of the livestock enterprise, and the operator's preferences.

5. Due to the wide range of acceptable technologies, design standards to meet environmental goals are impractical. In order to carry out the objectives of the Water Pollution Control Act of 1972, producers are to apply the "best available technology economically achievable" by 1983. If this terminology is retained as law, it should at least be viewed as a list of alternative technologies.

6. The goal of the Water Pollution Control Act of 1972 is "that the discharge of pollutants into the navigable waters be eliminated by 1985." This goal cannot be met completely by livestock producers without severe economic hardship, particularly to the small farmer.

7. In areas where a number of concentrated livestock facilities are located, the aggregate impact of individual pollution control practices

needs to be considered. Similar actions by many producers may overload the capacity of the environment to assimilate the waste in the event of unusual circumstances, e.g., a large rainfall event.

SECTION 4

REGIONAL ASPECTS OF LIVESTOCK PRODUCTION AND WASTE MANAGEMENT OPTIONS

Livestock production occurs in every state; however, the livestock industries are concentrated in various regions because of favorable climate, feed availability, proximity to market, labor availability, etc. Also, potential pollution problems, e.g., rainfall runoff, odor, or dust, are a function of climate specific to an area. The regional nature of livestock production and potential pollution problems lead to livestock management practices which are also regional. Pollution problems and pollution control practices are related to regional facility design and management.

This section identifies regional factors that affect livestock production, potential pollution problems and waste management practices. Wherever livestock are raised local pollution problems may occur. Just because this section considers only those regions where livestock production is concentrated, it does not exclude the need for pollution control on isolated livestock production facilities in other regions.

The regions established for the purpose of this manual are shown in Figure 1. The principal factors used in identifying the boundaries of each region are temperature, rainfall and moisture evaporation similarities, livestock production patterns and topographical features. Alaska is considered in the cold humid region and Hawaii in the hot humid even though the livestock management practices are significantly different in these two states.

CLIMATOLOGICAL AND HYDROLOGIC FACTORS

Both water quality and odor problems are affected by temperature, humidity, precipitation, evaporation, solar radiation and wind patterns. Moist and warm conditions increase the generation of odorous volatiles from livestock wastes. The principal water quality problem is polluted runoff from feedlots. The amount of runoff depends on the feedlot surface, evaporation and antecedent moisture conditions, rainfall intensity and duration, topography, vegetative cover, etc.

Regional patterns of temperature and annual moisture deficit are shown in Figure 2. The moisture deficit is the annual precipitation minus the potential evapotranspiration. In the humid regions, defined as having less than 10 inches of moisture deficit, evaporation of surface water does not significantly reduce the volume of wastewaters. The 80°F average July temperature line is included because warmer summer temperatures can stress

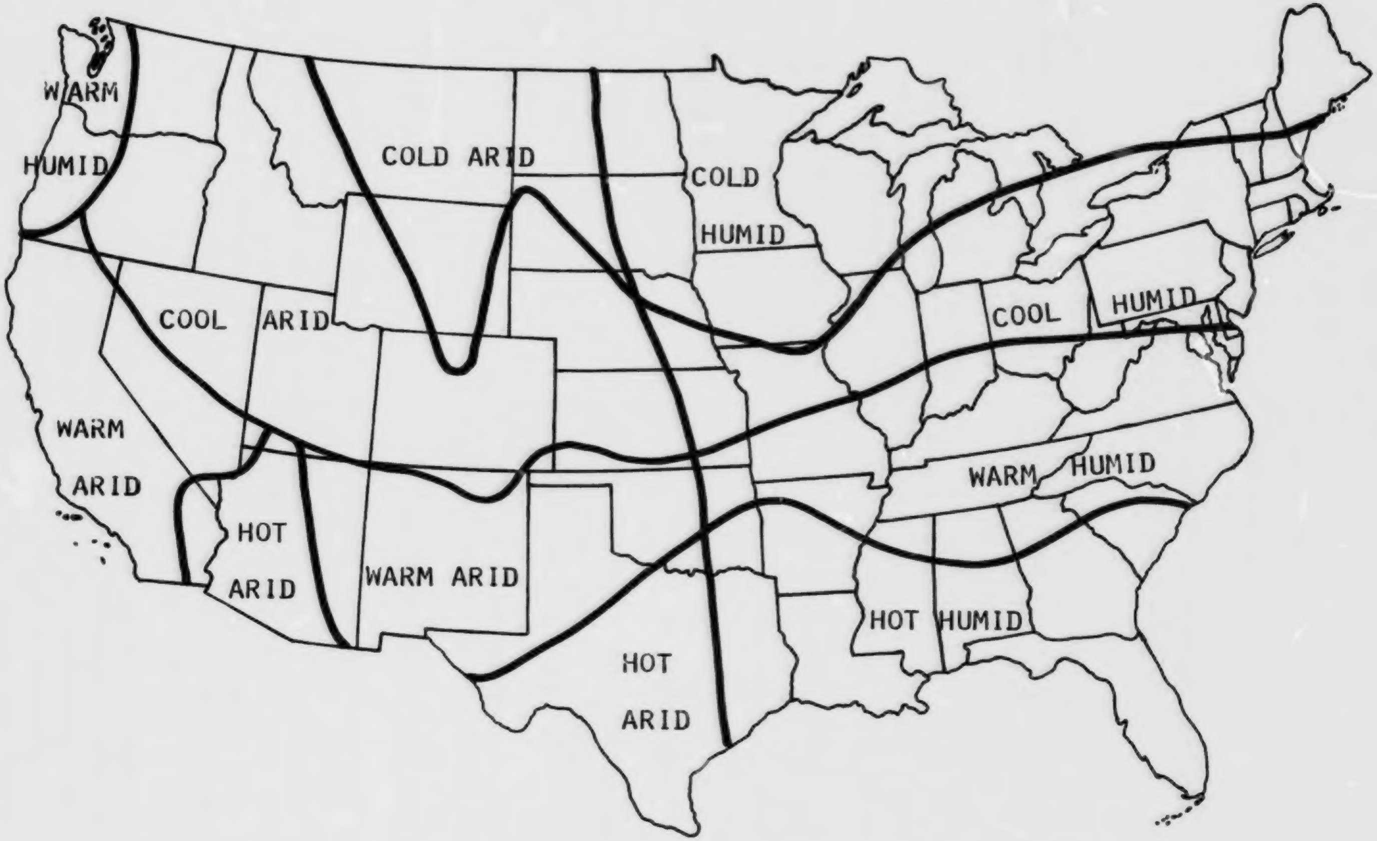
WARM
HUMID
COLD ARID
COLD
HUMID
COOL
ARID
COOL
HUMID
WARM
ARID
HOT
ARID
WARM ARID
WARM
HUMID
HOT
HUMID
HOT
ARID

Figure 1. Climatic regions of the continental United States used for grouping similar livestock waste management systems.

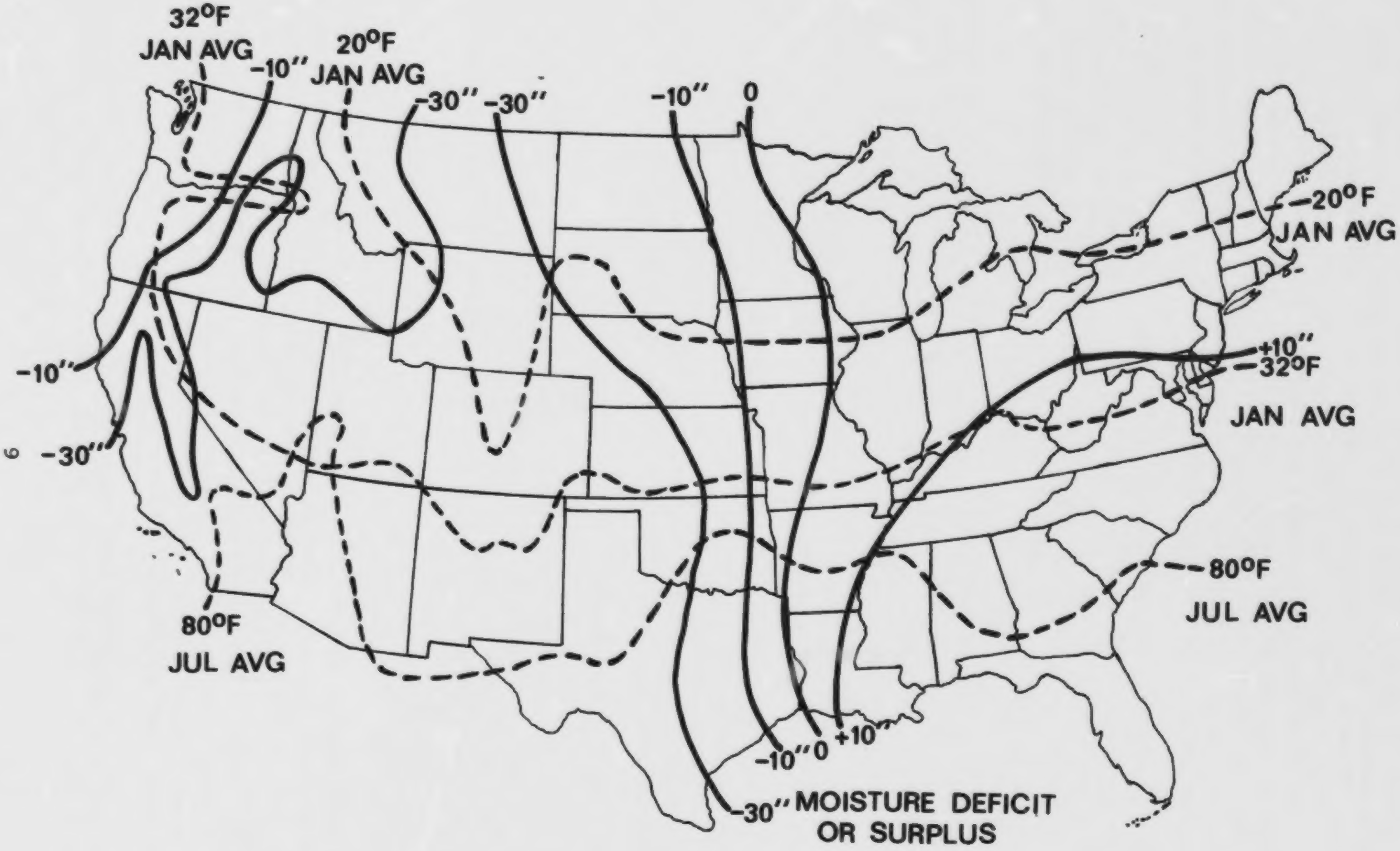
32°F
JAN AVG
-10"
20°F
JAN AVG
-30"
-30"
-10"
0
-20°F
JAN AVG
+10"
-32°F
JAN AVG
-10"
-30"
80°F
JUL AVG
80°F
JUL AVG
+10"
-10"
0
-30"
MOISTURE DEFICIT
OR SURPLUS

Figure 2. Regional patterns of temperature and annual moisture deficit or surplus (precipitation minus potential evapotranspiration).

livestock unless steps are taken to provide cooling or shade. North of the 32°F average January temperature line, waste management systems must allow for freezing of waste and wastewaters. North of the 20°F average January temperature line, insulated total confinement buildings with designed ventilation systems are often utilized to give improved livestock performance. Other climatic factors are related to livestock waste system design and management. For instance, solar radiation and wind influence the evaporation rate of moisture from lot surfaces. In warm climates, anaerobic lagoons can have a heavier loading rate without increasing the odor nuisance potential.

In regions of high rainfall, it may be advisable to reduce the area of exposed lot surface in order to minimize runoff. In states with more than 10 inches of moisture deficit and having cool to warm winters, open feedlots are most common. In these drier regions, runoff control is usually total detention and irrigation. In the more humid states, runoff may also be controlled using a settling basin/grass infiltration area.

Freezing weather not only affects design of waste treatment facilities but it also usually requires a storage facility. Such storage facilities allow the farmer to schedule his field application to avoid adverse soil and weather conditions and conflicts with crop production. The wastes should be stored in the designed structures until they can be spread and incorporated into the soil. Incorporation will reduce pollutants-laden surface runoff, will reduce odor nuisance, and will conserve fertilizer nutrients.

The topography affects both lot runoff and the runoff from land application sites. The slope of the land affects the amount of runoff and the amount of suspended pollutants in the runoff. Both the size of the feedlot (drainage area) and the distance of the feedlot to a flowing stream as well as topography need to be considered in selecting runoff control facilities.

OTHER REGIONAL CONSIDERATIONS

Agricultural land use planning or zoning is being done in many states. These plans usually stipulate the type of agricultural production facilities that may be built. It is expected that the zoning requirement will eventually indicate what type of waste management systems are suitable for the region.

SPECIES LOCATION

The location of the beef cow-calf enterprise is geographically dispersed throughout the U.S. Leading states are found in the central part of the U.S. and include Texas, Oklahoma, Missouri, Kansas, Nebraska, Iowa, and South Dakota. However, substantial beef cow numbers are found in the Northern Great Plains, North Central, Southeastern, Southwestern and Northwestern Regions. Although large herds are found in western states, there is a wide range in herd sizes in all producing areas. The principal areas of cow-calf production are shown in Figure 3.

Fed beef production is more concentrated than cow-calf production as shown in Figure 4. Leading states include Texas, Iowa, Nebraska, and Kansas.

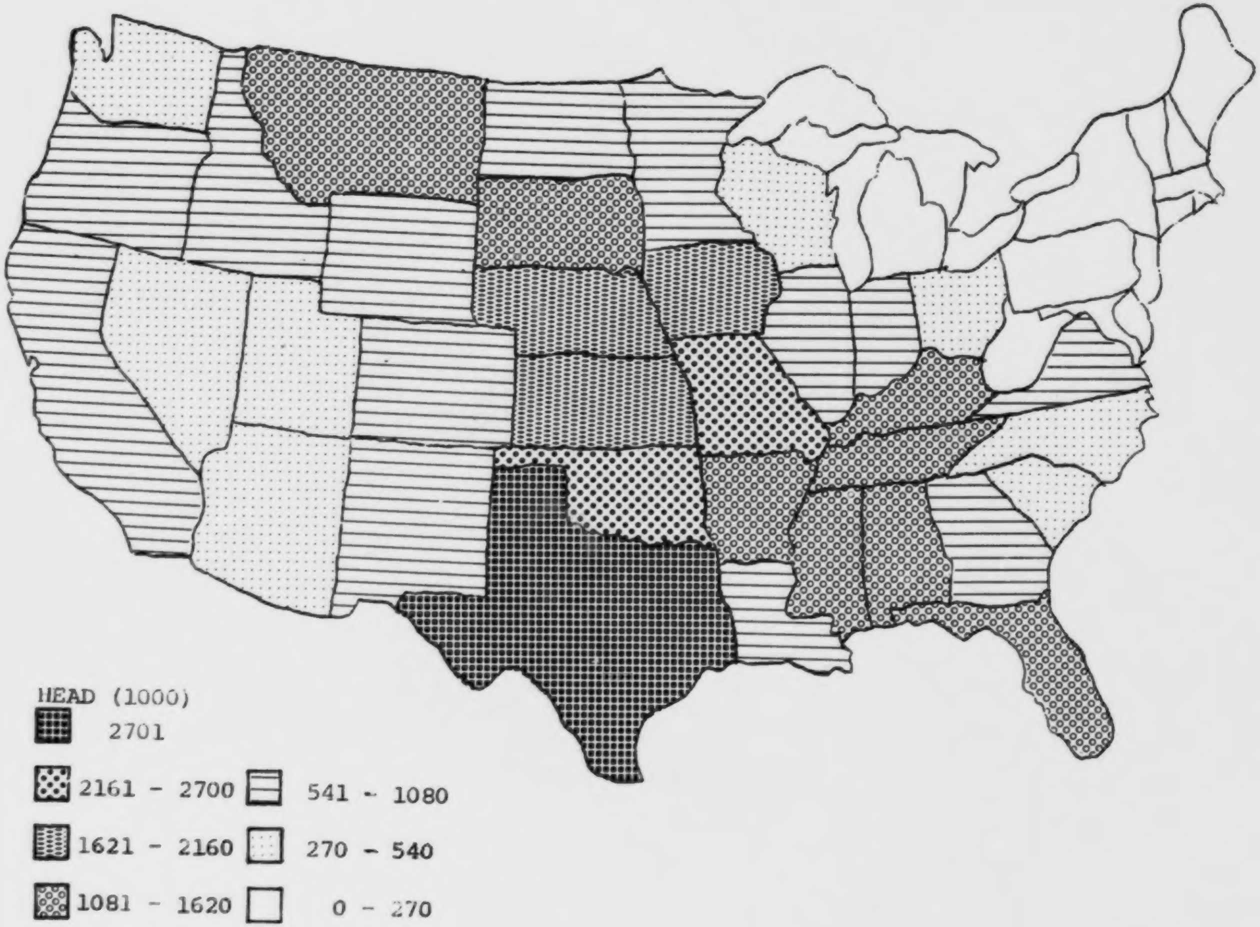
HEAD (1000)
2701
2161 - 2700
1621 - 2160
1081 - 1620
541 - 1080
270 - 540
0 - 270

Figure 3. Beef cow-calf production in the United States (cows and heifers that have calved January 1, 1977).

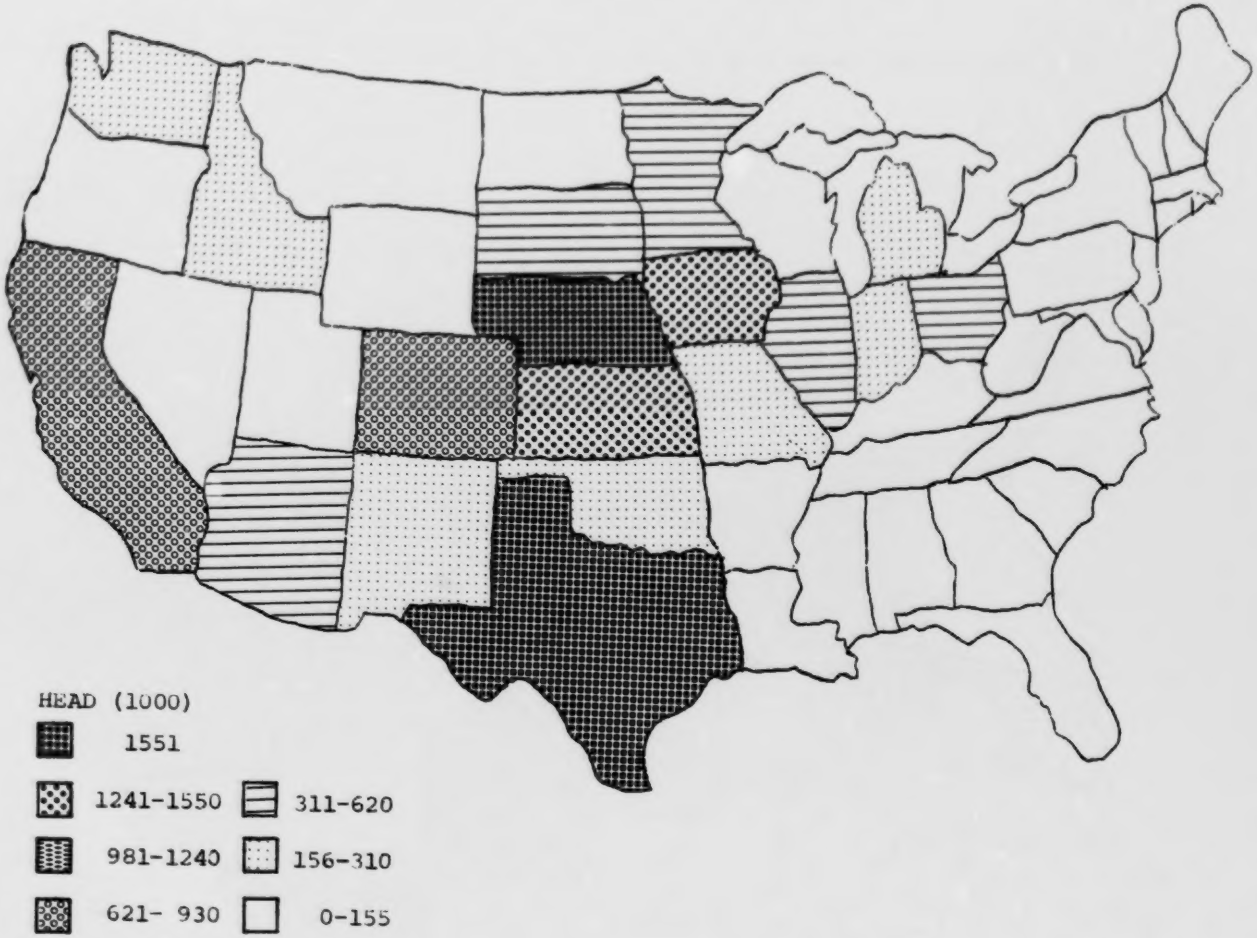
HEAD (1000)
▦ 1551
▩ 1241-1550
▤ 981-1240
▩ 621- 930
▤ 311-620
⬚ 156-310
☐ 0-155

Figure 4. Fed beef production in the United States (number on feed, January 1, 1977).

A second tier of states includes California and Colorado. Numbers in other states then drop rapidly. States of secondary importance in fed beef production are the Corn Belt states of Illinois, Indiana, Michigan, Minnesota, Missouri, Ohio, and South Dakota; Northwestern states of Idaho and Washington; and South Central states of New Mexico and Oklahoma. Many feedlots in the western half of the nation are subject to the National Pollution Discharge Elimination System (NPDES), since they have capacities greater than 1000 animal units. The vast majority of feedlots in the Corn Belt states have less than 1000 head capacities.

The primary hog producing states are found in the Corn Belt and Southeastern U.S. (Figure 5). Iowa, Illinois, Indiana, and Missouri are leading hog producing states with Minnesota, Nebraska, North Carolina, Ohio, and Georgia also being important. Many of the Southeastern states are important sources of feeder pigs for later concentrated feeding in Corn Belt states.

The ewe and lamb enterprise is geographically dispersed in many states (Figure 6). Like the beef cow-calf herd, it is an enterprise commonly used to take advantage of forage production from land not suitable for crops. Important states for stock sheep are Texas and Wyoming, with California, Utah, Montana, South Dakota, and New Mexico being other important states. North Central states are of secondary importance for the ewe and lamb enterprise. The pattern of fed lamb production shows high concentrations in Western states, primarily in Califonia, Colorado, Texas and Wyoming. North Central, Northern Plains, and other Western states are of secondary importance in fed lamb production. The inventory of lambs on feed as of January 1, 1976 is shown in Figure 7.

Wisconsin, California, Minnesota, and New York are the predominant dairy states, followed by Pennsylvania, Michigan, Ohio and Iowa (Figure 8). Most of the other states in the eastern half of the country are of secondary importance in dairy production.

The location of poultry production varies widely, depending on the species. Layers are dispersed with Arkansas, California and Georgia being leading states, followed by Alabama, Florida, Pennsylvania, Indiana, Minnesota, North Carolina, and Texas (Figure 9). Layers are also found in many other states throughout the eastern half of the country. Commercial broiler production is highly concentrated in the Southeast, with Arkansas, Alabama, and Georgia being principal broiler production states, followed by North Carolina and Mississippi (Figure 10). Turkeys are largely concentrated in three states, California, Minnesota, and North Carolina, with states of secondary importance including Missouri, Texas, and Arkansas (Figure 11). Many states have little or no production of turkeys.

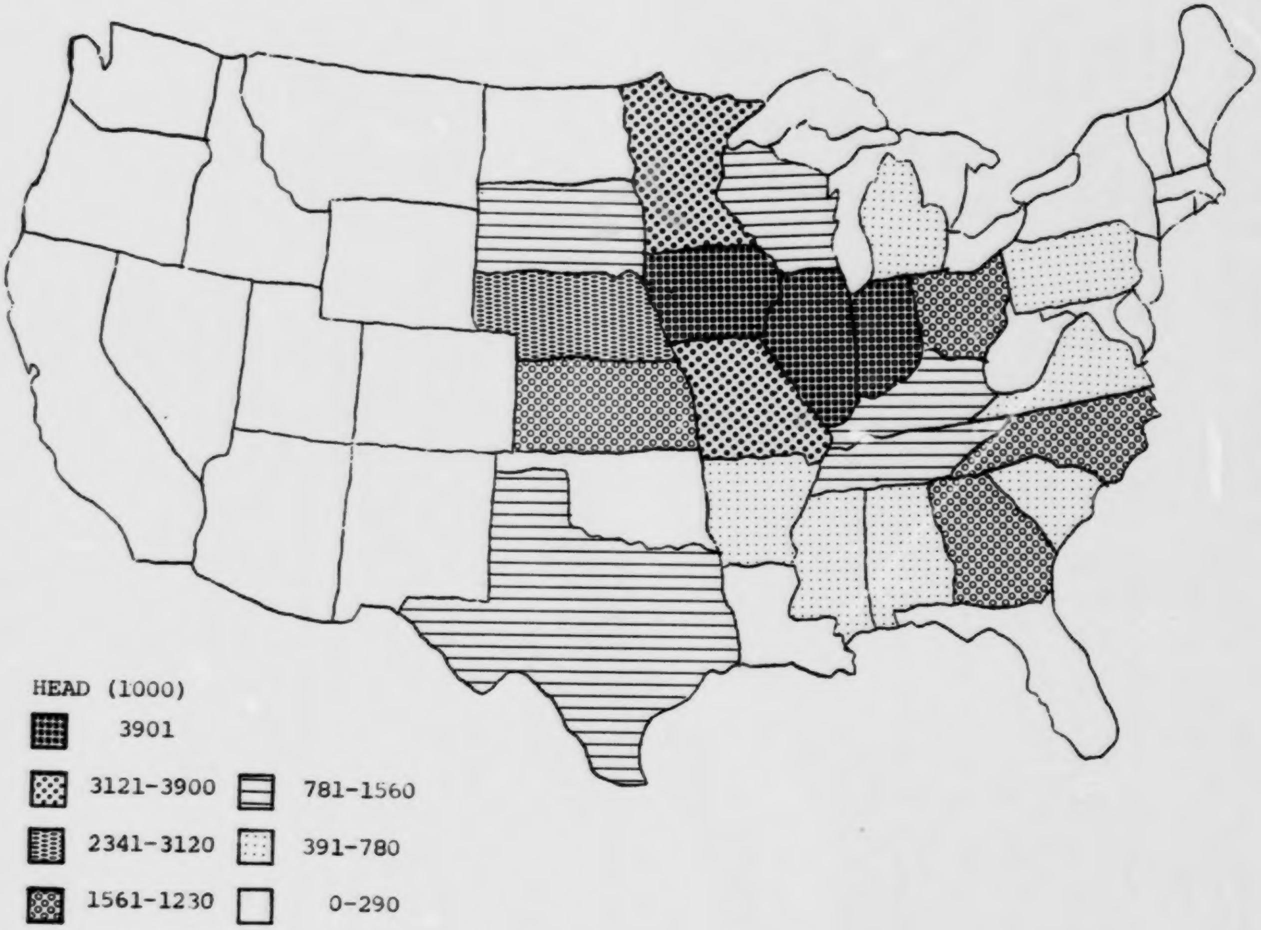
HEAD (1000)
▦ 3901
▨ 3121-3900
▤ 2341-3120
▩ 1561-1230
☰ 781-1560
⬚ 391-780
☐ 0-290

Figure 5. Fed hog production in the United States (number on farms, December 1, 1975).

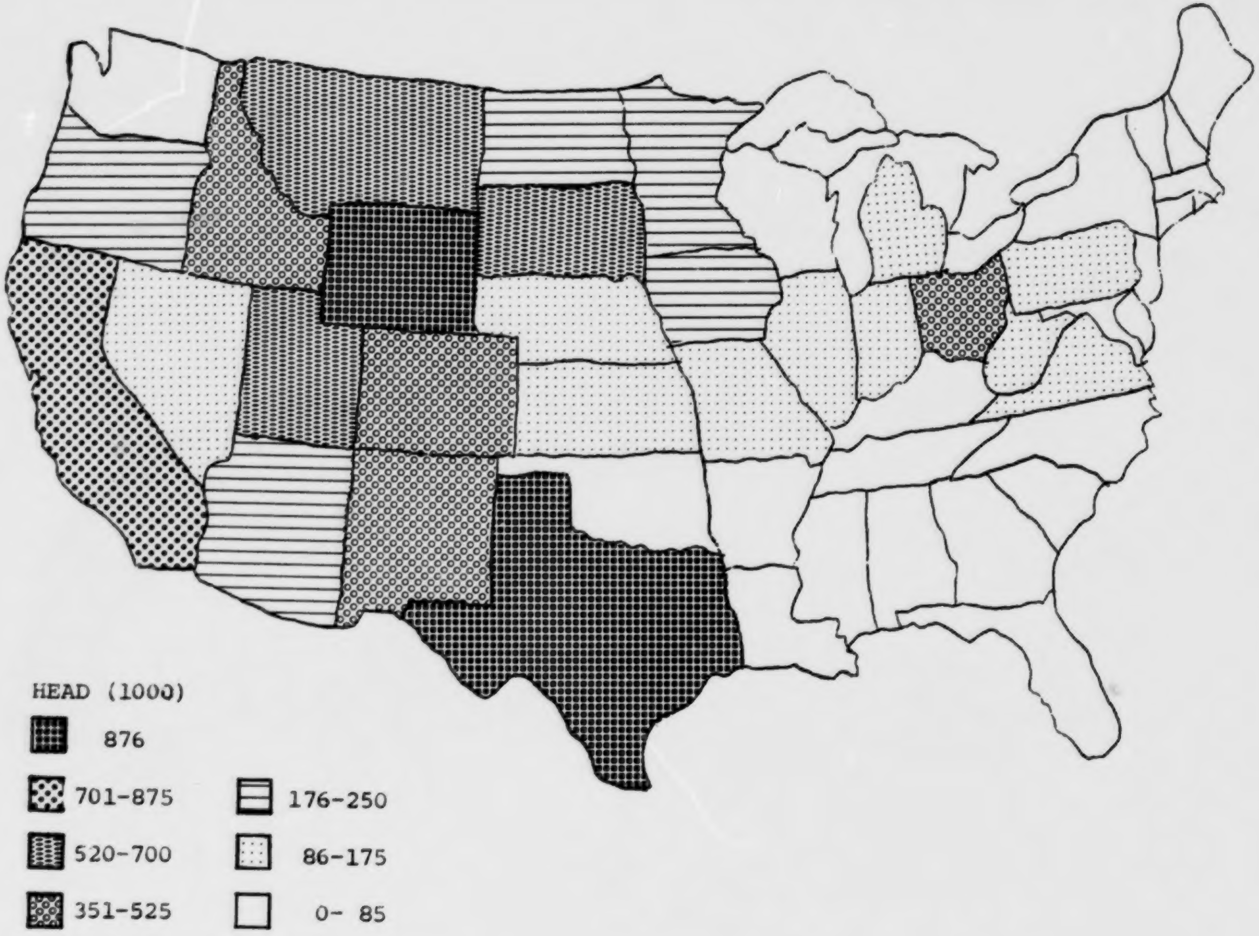
HEAD (1000)
876
701-875
520-700
351-525
176-250
86-175
0- 85

Figure 6. Sheep (ewe and lamb) production in the United States (number in breeding flocks January 1, 1977).

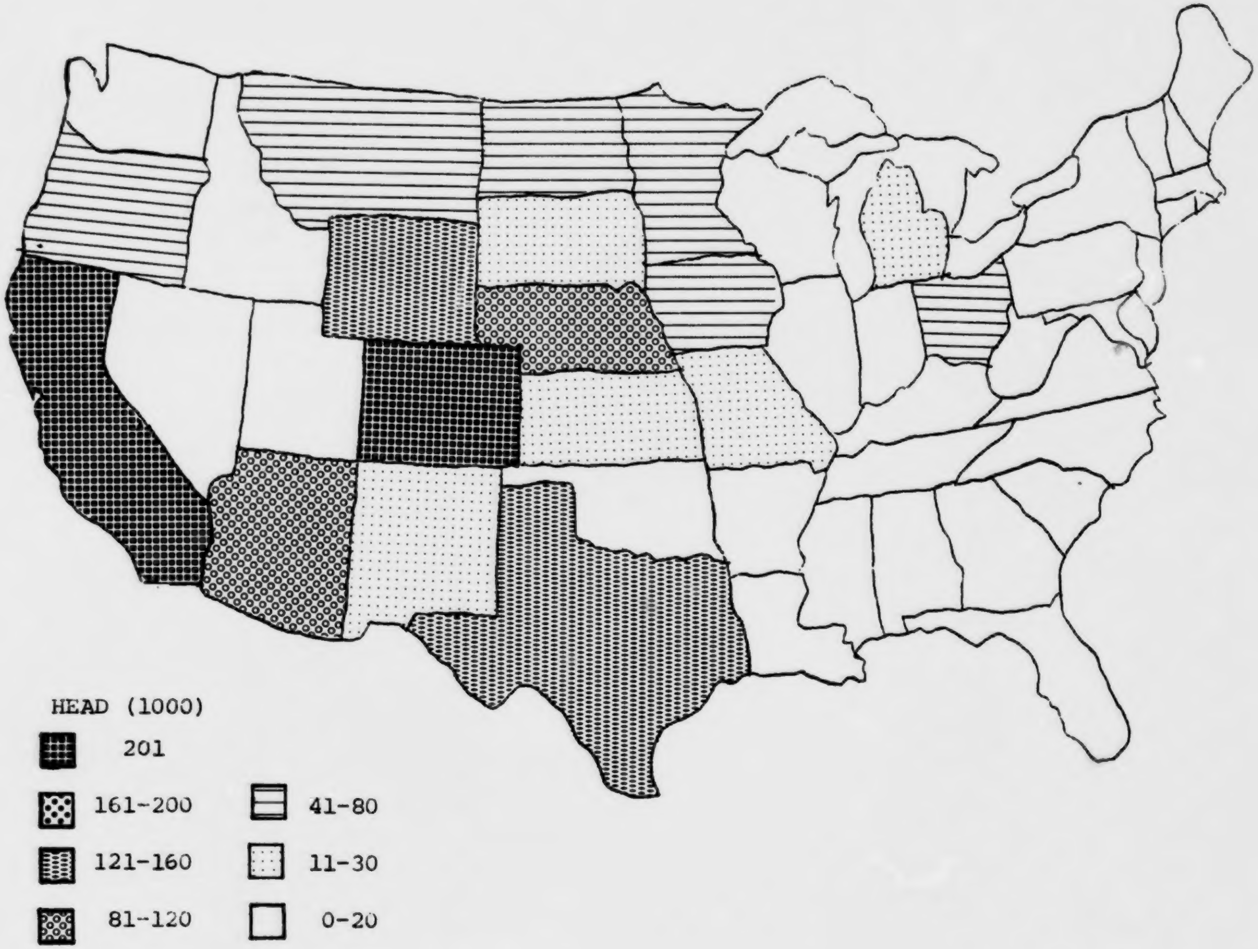
HEAD (1000)
201
161-200
121-160
81-120
41-80
11-30
0-20

Figure 7. Fed lamb production in United States (number on feed January 1, 1976).

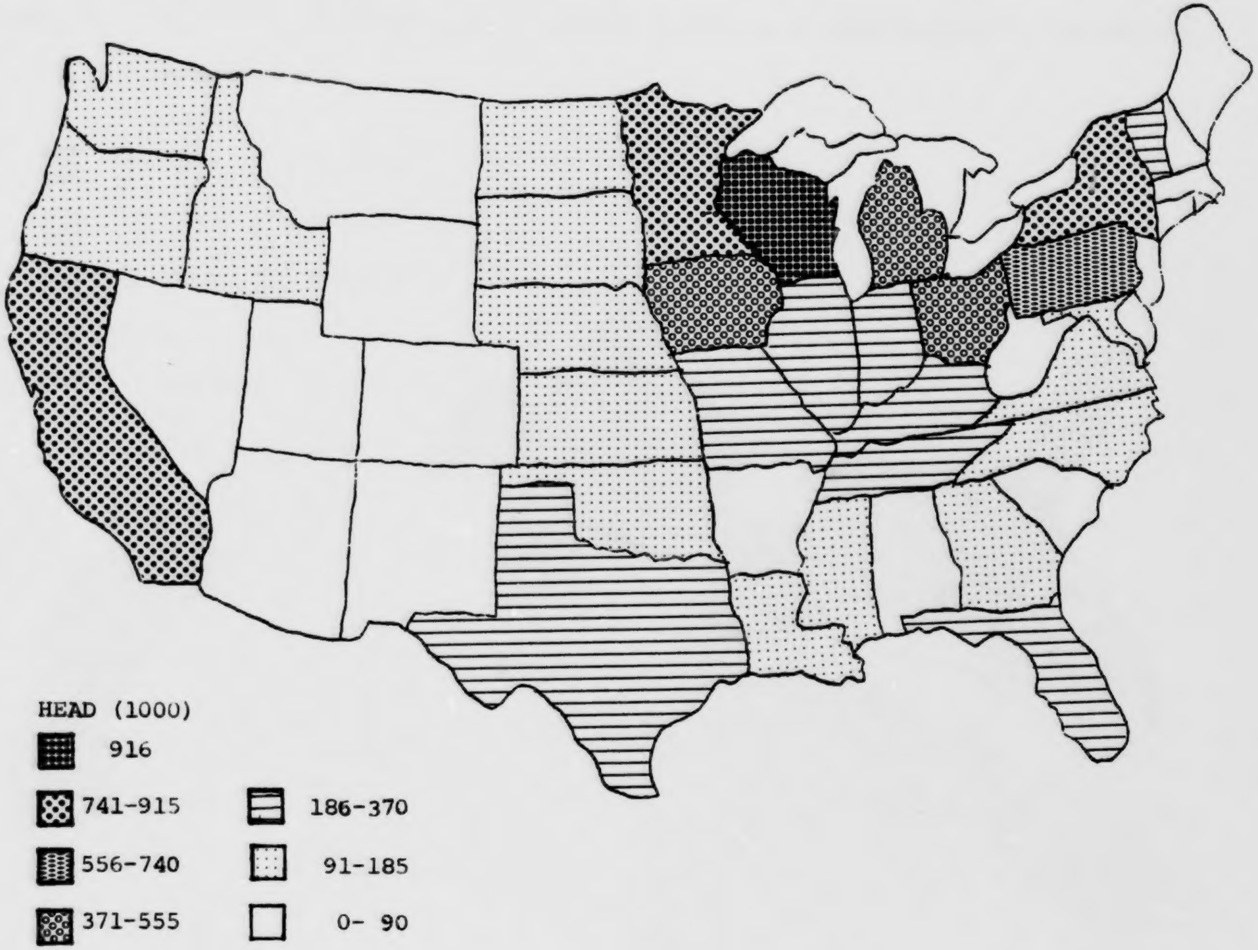
HEAD (1000)
916
741-915
556-740
371-555
186-370
91-185
0- 90

Figure 8. Dairy-milk cows on farms in United States (cows and heifers that have calved January 1, 1976).

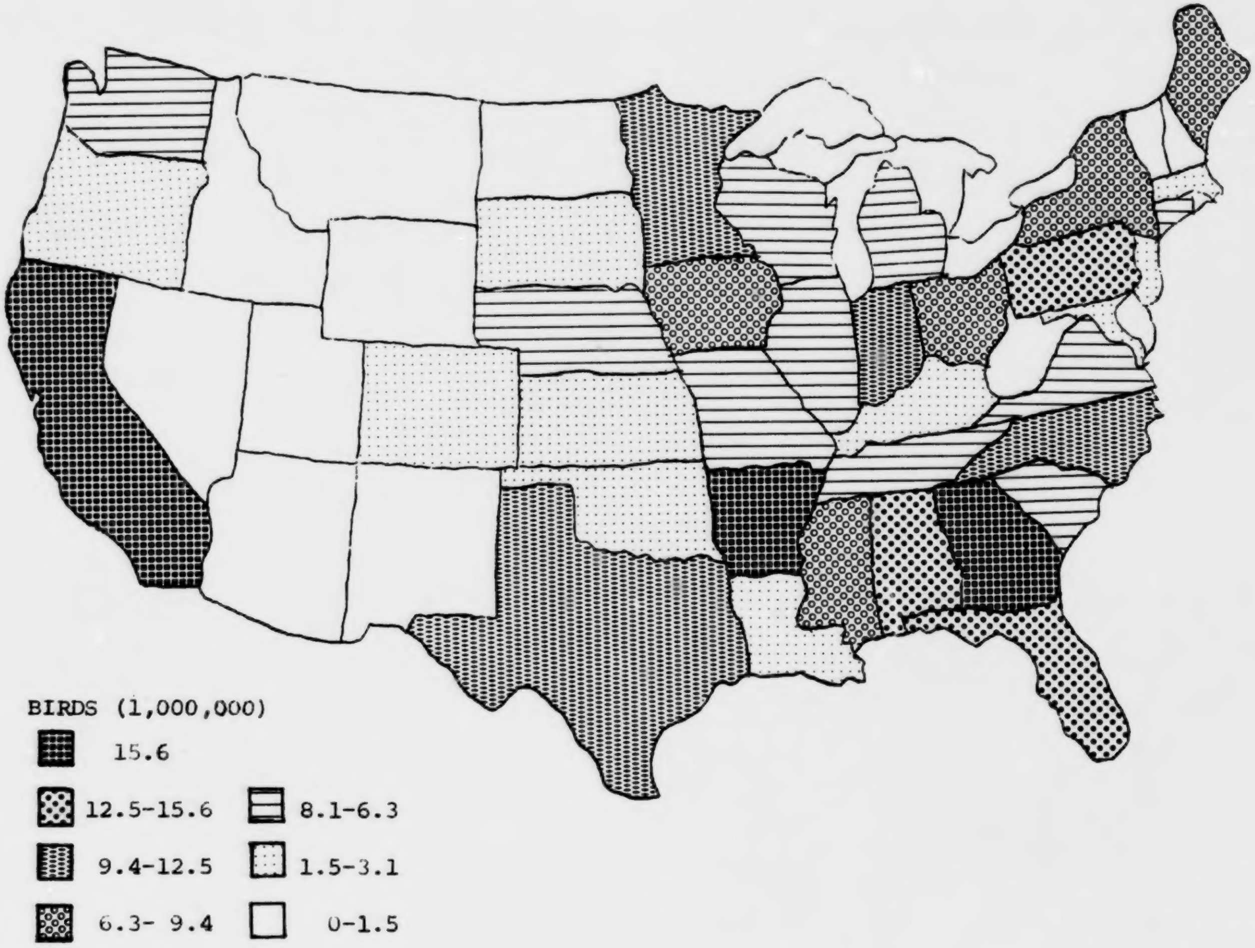
BIRDS (1,000,000)
▦ 15.6
▨ 12.5-15.6
▤ 8.1-6.3
▥ 9.4-12.5
☐ 1.5-3.1
▩ 6.3- 9.4
☐ 0-1.5

Figure 9. Laying hens in production in United States (hens and pullets of laying age December 1, 1976).

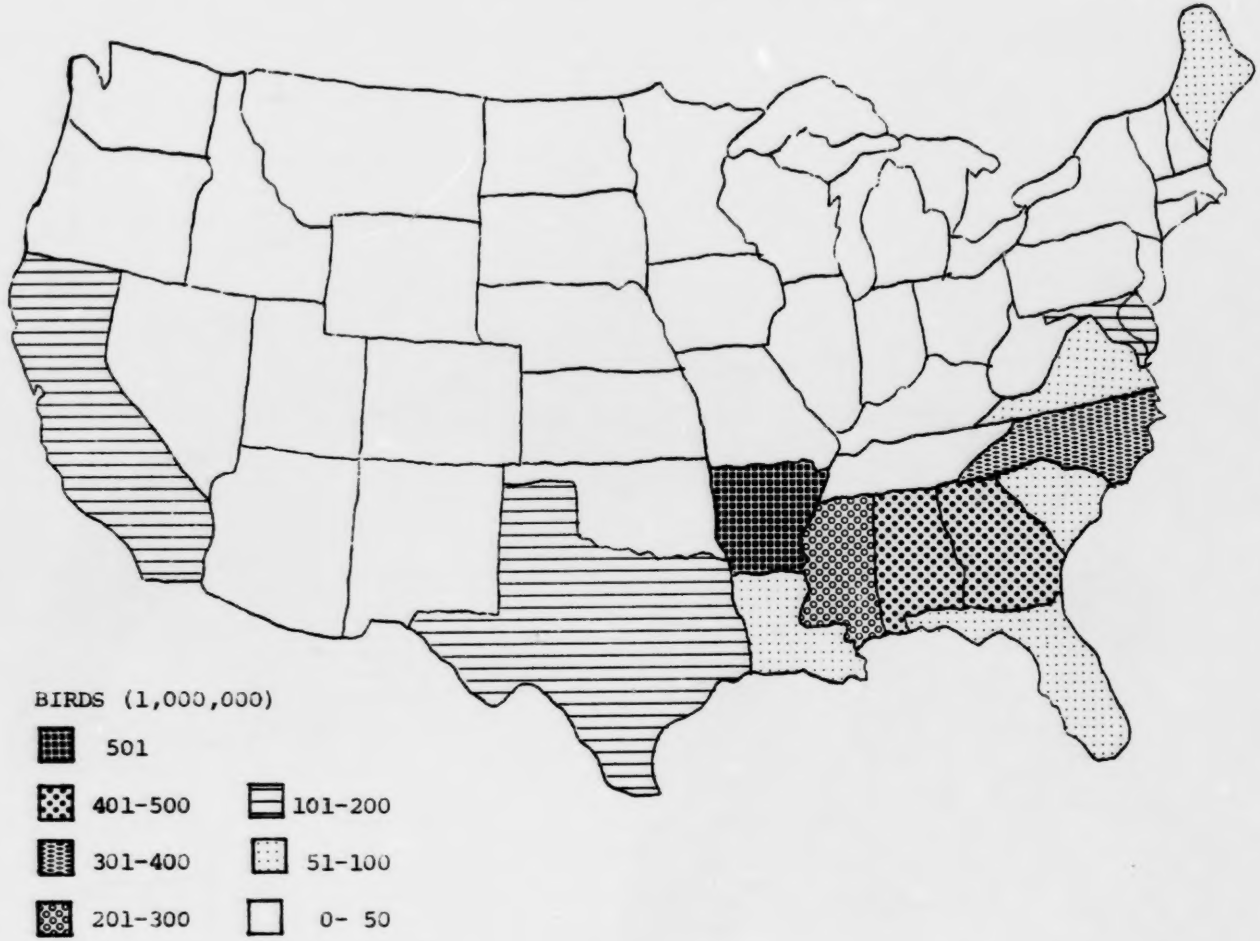
BIRDS (1,000,000)
▦ 501
▦ 401-500
▦ 301-400
▦ 201-300
▤ 101-200
▨ 51-100
☐ 0- 50

Figure 10. Commercial broiler production in United States (1976).

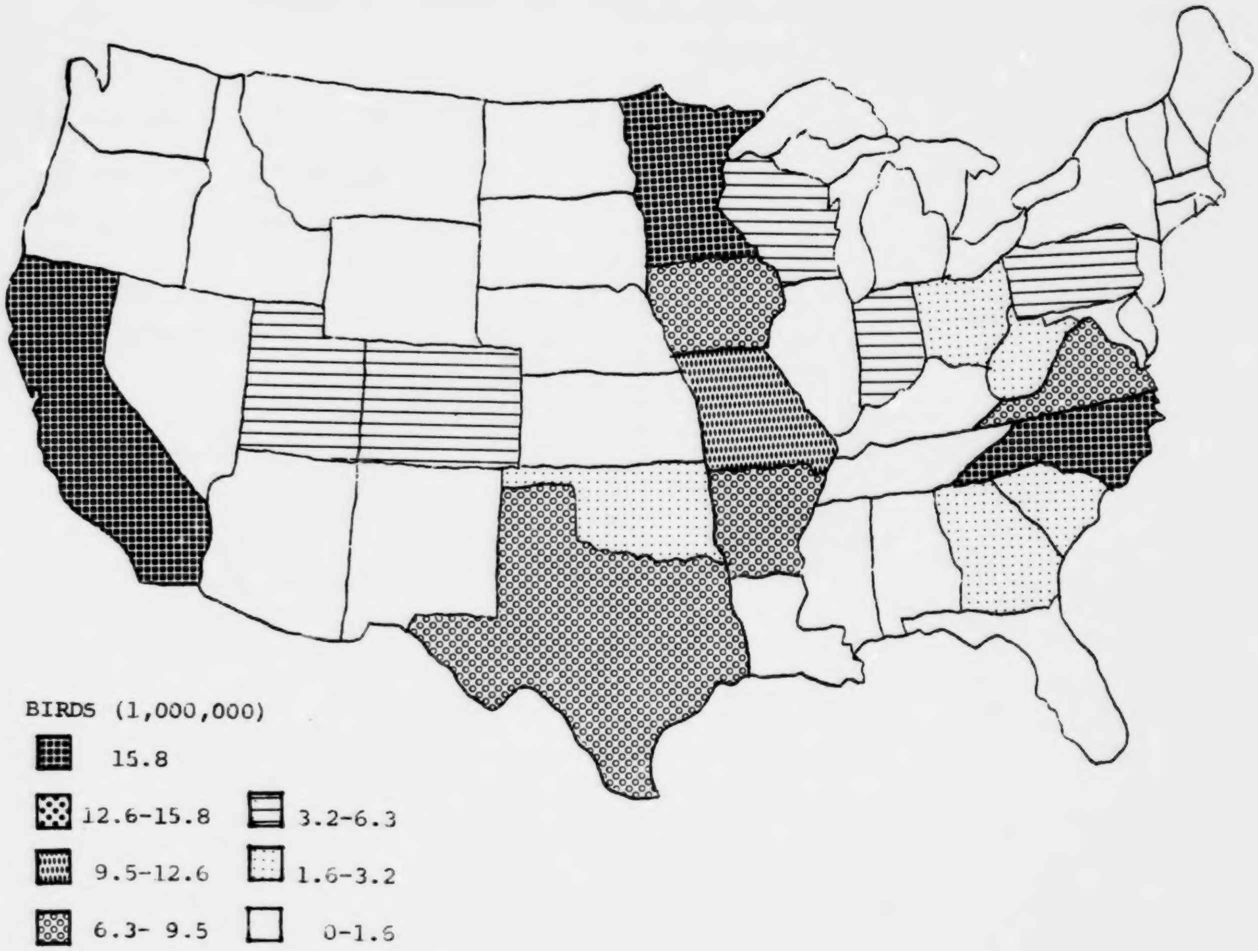
BIRDS (1,000,000)
15.8
12.6-15.8
9.5-12.6
6.3- 9.5
3.2-6.3
1.6-3.2
0-1.6

Figure 11. Turkeys raised in United States (1976).

SECTION 5

SELECTING WASTE MANAGEMENT OPTIONS

One objective of the manual is to identify and outline alternative waste management systems which are suitable to control pollution from small farms, barnyards and pastures. Waste management systems commonly being used are identified for each species: dairy, beef, swine, sheep and poultry. In addition, certain advanced systems which control pollution are described. Also, the benefits and costs of the various waste management options and pollution control practices are analyzed and evaluated.

The engineering design of waste management systems or components of the system is not the intent of this manual. The reader may wish to refer to the Bibliography for bulletins and handbooks giving design information for waste systems in general and for systems specific to each species. Publications giving design criteria for feedlot runoff system components are also included in the Bibliography.

WATER QUALITY CONSTRAINTS

Both surface water and ground water quality are affected by pollutants from livestock operations. This manual will address the impact of livestock operations on the quality of receiving streams. The sources of water pollutants may be put into three categories: (1) rainfall runoff from confinement areas, (2) runoff from pasture production of livestock, and (3) runoff from land with manure spread on it. Each of these sources will be considered in turn.

Feedlot (Barnyard) Runoff

The U.S. Environmental Protection Agency in the Federal Register on March 18, 1976, promulgated regulations pertaining to concentrated animal feeding operations. Criteria were stated for livestock production facilities that would be required to obtain a National Pollutant Discharge Elimination System (NPDES) permit. The primary thrust of the Concentrated Animal Feeding Operations regulation was to control runoff. Different conditions were applied according to the size of the animal production facility. The first criterion referred to discharge of pollution from the feedlot. A second criterion was whether pollutants were discharged into waters passing through or coming in contact with animals in the confined area. The intent of this regulation is to eliminate the discharge of pollutants into surface waters.

The runoff from confinement areas may contain high concentrations of organic material and dissolved salts. Factors affecting the degree of pollution are the amount of precipitation, number of animals, type of animals, type and size of feedlot surface, management practices, etc. From one-fourth to one-half of the annual precipitation may become runoff.

There are two types of runoff pollution control systems: (1) a system which collects all the runoff, detains it in storage and subsequently irrigates on cropland, and (2) a system which collects all runoff, settles out particles, and provides for infiltration and/or filtration in vegetated strips to clarify the effluent. Essential to both systems is the diversion of all outside surface water and roof water away from the manured area.

The detention basin-irrigation system is used mainly in the dry and arid regions and is stipulated in some state regulations, e.g., Kansas. The settling basin-infiltration strip system is generally used by farmers in more humid regions and is used particularly with small livestock facilities. It is the recommended runoff management practice in states such as Ohio and Indiana. The detention basin-irrigation system is illustrated in Figure 23 and the settling basin-infiltration strip system in Figure 31.

Runoff from Pasture

A distinction is made between "pasture" and "range". A pasture normally has been improved with fertilization and selected grasses and generally will carry more animals per unit area. The use of pastures is a major component of most types of stock production. Feeder calves are produced almost exclusively on pasture or range. About 30% of hog production is still on pasture. Most dairy farms, except for the Southwest, use pasture when seasonal conditions permit. Sheep production is mainly a range and pasture operation.

Good livestock and pasture management is the best insurance against pollution of water from pasture livestock production. The relative importance of management practices differs by type of livestock and regions of the country. General management practices which apply are as follows:

1. Maintain a stocking density and rotation of grazing to prevent overgrazing and subsequent erosion.

2. Maintain a highly productive forage on the land to retard runoff, trap animal wastes and utilize nutrients.

3. Locate feeders and waterers a reasonable distance from streams and water courses. Move feeders (waterers) to new locations often enough to avoid creating "holding areas" and cattle paths that will erode.

4. Provide summer shade to lessen the need for livestock to enter streams for relief from heat.

5. Utilize good water erosion control practices to control runoff.

If the above management practices are followed, the need for limiting livestock access to streams or providing a buffer strip between the pasture and stream will be minimized.

Runoff from Manure-Applied Land

The most common and still the most acceptable method for disposing (utilizing) of livestock wastes is application to cropland. It is not the purpose of this manual to detail management guidelines and application criteria for spreading manures on cropland. The reader is referred to a companion USEPA publication, Animal Waste Utilization on Crop and Pasture Land by Gilbertson, 1977 (in press).

Some good management practices which should be considered are:

1. Determine plant nutrient value of the waste and apply it to the land according to crop requirement. The nitrogen requirement of the crop is the usual basis for determining the application rate. However, applying manure according to the phosphorus or potassium needs of the crop and providing supplemental nitrogen fertilizer as needed may be more economical.

2. Schedule the timing of manure applications for efficient nutrient utilization by plants, e.g., spring applications versus fall application.

3. Inject liquid wastes into the soil or incorporate manure as soon as possible after spreading. Nitrogen losses through ammonia volitilization may be as large as 20% in six hours or 45% in three days.

4. Ensure that enough land is available for spreading when manure must be moved.

5. Apply manure to sloping lands only when vegetative cover is on the field. Avoid application to sloping land when frozen and snow-covered.

6. Utilize good sediment erosion control practices to control runoff.

These practices involve good agronomic and soil conservation management factors which in turn reduce the pollution potential.

AIR-BORNE NUISANCES

The principal nuisance is odor. In some cases, dust may be the principal air-borne nuisance and be the carrier of odor. Odorous gases and volatiles are produced in the biological decomposition of manure. Manures in the liquid form are particularly odorous. Freshly excreted manure will not usually have as offensive odors as when the manure has been stored.

The trend towards larger, confined livestock operations with manure storage increases the possibility of odor nuisance.

The odor nuisance problem is compounded by the subjective nature of odor and the difficulty in field testing. No acceptable standards for odor intensity or concentration of volatile compounds have been developed.

Siting of livestock buildings, storage basins and treatment lagoons is important for minimizing odor nuisance. The prevailing winds should be away from the closest neighbors, and away from the farmstead. The livestock waste facility should be located as far as possible from neighbors.

Good management decisions with respect to spreading manure on cropland can decrease the odor nuisance for neighbors. Spread when there is a wind to disperse the odor. Spread in the morning when the air is likely to be rising. Select fields for application that are farthest away from neighbors or that have the wind blowing away from the neighbors.

When manure must be spread in large quantities, soil incorporation may be the only method to adequately abate the odor nuisance. Commercial injection equipment is available for most tank wagons for liquid manure handling. If the manure must be spread on the ground surface, immediate incorporation will control the odor nuisance.

Several commercial odor control products are available from agricultural supply stores. The effectiveness of these chemicals varies with the type of waste, storage conditions and disposal method. These products may work for short-term situations but generally have not been effective as long-term solutions for odor problems.

ECONOMIC EVALUATION

Benefits and costs of alternative waste disposal systems are a primary determinant in selecting a waste management system. When faced with the added costs of controlling pollution, many producers may face the final choice of whether or not to remain in the livestock business. Thus, the producer needs to closely examine the economic factors associated with alternative systems.

Most waste disposal systems for concentrated animal feeding operations of less than 1000 animal units have costs which clearly exhibit economies of size. That is, as production from the livestock operation increases, per unit waste disposal costs decrease. For example, the 100 and 400 head capacity beef feedlots with paved open lot construction (25 sq ft paved lot inside and 30 sq ft paved lot outside per head) have nearly the same requirements for investments in manure spreaders, loaders, and scrapers. Therefore, costs per head on the 400 head lot would be smaller than on the 100 head lot. The immediate dilemna that is fostered by these economies of size is how to improve water quality without burdening the small producer with substantial costs which may force him out of business.

Due to these characteristics of the livestock industry where profits are squeezed and economies of size in waste disposal technologies predominate, this manual outlines net waste disposal system costs for a range of technologies and a range of size levels. For each livestock species, several waste disposal systems are investigated and the systems are applied to several herd sizes. The intent is to present these ranges in relevant system costs and returns in order to assist in rational decision making by both livestock producers and pollution control authorities.

Relevant System Costs and Returns

Both society and livestock producers have a stake in the selection of disposal systems. Quantifying the level of the stake is the intent of the estimates of net disposal costs. The farmer's stake is defined by the benefits of nutrients produced by the system and the costs incurred. Allowing a return to nutrients assumes that the farmer values wastes as a resource to be used in an economic fashion. That is, he uses the wastes to supply nutrients to plants and/or recycles the wastes as a source of energy or feed. Using the wastes as a nutrient source for plant growth is a primary benefit from wastes with current technologies. Thus, in this manual, the only estimated benefits flowing to the farmer are the values of plant nutrients supplied by the wastes.

The costs borne by the farmer are assumed to be the total costs associated with the livestock waste system. The problem in estimating these costs is that the waste disposal system is an integral part of the total livestock enterprise. Where the housing system ends and waste disposal begins or where the feeding system ends and waste disposal begins is often arbitrary. While recognizing the interdependency of waste, feeding and housing components of the livestock enterprise, the authors focus only on the waste system. Farmers' costs and returns must be put in the perspective of the total livestock enterprise before prescriptions are made about the best waste system.

The stake which society has in livestock pollution control includes the farmer's interests as well as the "externalities" of the livestock unit. These externalities are in the form of costs which the farmer does not bear but which accrue to society. The costs of water pollution and air pollution are externalities flowing from confined animal feeding operations and are the cause for the interest in livestock production outside the agricultural community.

Placing a monetary value on water and air pollution costs is not feasible. The effect of runoff and odor on downstream or downwind users of water and air cannot be determined precisely. Therefore, the costs of externalities are best estimates in a qualitative sense. Scales ranging from "severe pollution" to "no pollution" have been established to provide estimates of water pollution costs for each waste disposal system.

Benefits from Nutrients in Waste

Availability of nitrogen, phosphorus and potassium is highly dependent on the species, size of animal, housing, storage, and handling method. Nitrogen is the nutrient which has the greatest variation in availability between waste disposal systems. Nitrogen may be in the ammonia, nitrate/nitrite, or organic form. The system components used to store, handle and spread the waste may allow the ammonia portion to be lost to the air or the nitrate/nitrite portion to leach through the soil or lot surface. Generally, most of the phosphorus and potassium produced by the animal is available to crops when spread. Exceptions are open lot and lagoon systems which permit greater losses of phosphorus and potassium than do other systems.

Costs to Farmers

Both variable and fixed costs must be considered when installing a pollution control system. Variable or operating and maintenance costs are those costs which vary as output from the facility changes. For example, if an enclosed free stall dairy barn designed for 120 head is used for only 60 head, some per unit costs such as labor costs would be substantially less than if the facility would be filled to capacity.

Other costs do not change as output from a facility changes. For example, the facility loses some of its value each year due to depreciation, and depreciation occurs with or without animals using the facility. Thus, depreciation is an example of a fixed cost. Fixed costs are associated with durable inputs or those capital investments which remain over several time periods. The following items are fixed costs.

a. Depreciation represents the annual charge for the use of the durable input. In budgeting costs, depreciation is the following:

$$\text{annual depreciation} = \frac{\text{original investment - salvage value}}{\text{useful live}}$$

If the salvage value is zero the formula is

$$\text{annual depreciation} = \begin{pmatrix}\text{Original}\\ \text{Investment}\end{pmatrix}\left(\frac{1}{\text{Useful life}}\right)$$

For a non-depreciating input such as land, the annual depreciation is zero.

b. Interest represents the average earnings foregone by having capital tied up in the fixed input. It is calculated by:

$$\text{annual interest charge} = \left(\frac{\begin{matrix}\text{Original} \\ \text{Investment}\end{matrix} + \begin{matrix}\text{Salvage} \\ \text{Value}\end{matrix}}{2}\right)\begin{pmatrix}\text{Interest}\\ \text{Rate}\end{pmatrix}$$

If the salvage value is zero the formula is:

$$\text{annual interest charge} = \left(\frac{\text{Original Investment}}{2}\right)\left(\text{Interest Rate}\right)$$

To apply this last formula, the input must be a depreciable asset such as buildings or equipment. For a non-depreciating input such as land the formula would be:

$$\text{annual interest charge} = (\text{original investment})(\text{interest rate})$$

c. Repairs and maintenance are partially fixed and partially variable. The new barn needs an occasional painting whether it is used or not. Typically, it is assumed that the building or piece of equipment will be used for production throughout its lifetime, and both variable and fixed repairs are lumped into one charge. The annual charge is assumed a constant percentage of new cost.

$$\text{annual repair charge} = (\text{original investment})(\text{repair percent})$$

These repair rates are based largely on repair and maintenance information in farm management publications from several universities.

d. Insurance is calculated by multiplying the average investment value by the insurance rate. If the salvage value is zero, the annual insurance cost is:

$$\text{annual insurance cost} = \left(\frac{\text{original investment}}{2}\right)\left(\begin{array}{c}\text{insurance}\\ \text{rate}\end{array}\right)$$

e. Taxes are charged in most states on an asset regardless of its use. Many states have real property and personal property taxes which are levied at a rate which varies from state to state. To estimate an average annual charge, the computation would be:

$$\text{annual tax charge} = \left(\frac{\begin{array}{c}\text{original}\\ \text{investment}\end{array} + \begin{array}{c}\text{salvage}\\ \text{value}\end{array}}{2}\right)\left(\begin{array}{c}\text{assessment}\\ \text{ratio}\end{array}\right)\left(\begin{array}{c}\text{tax}\\ \text{rate}\end{array}\right)$$

The assessment ratio is the assessed value of the property divided by the market value. The costs estimates used in this publication do not include an annual tax charge since the charge is relatively minor and varies between states.

For the purpose of this publication, salvage value of depreciable assets is assumed to be zero for the above fixed costs computations. Thus, the annual charge is a constant percentage of the original investment outlay as shown in Table 1 for each of the waste disposal system components.

TABLE 1. PERCENTAGES USED IN COMPUTING ANNUAL FIXED COSTS, FOR STRUCTURES AND EQUIPMENT

Component	Component Number	Estimated Years Life	Assumed Annual Costs (% of original investment)				
			Total =	Depreciation +	Repairs and Maintenance +	Interest +	Insurance
Concrete floor	1	20	11.0	5.0	1.0	4.0	1.0
Concrete lot	2	20	11.0	5.0	1.0	4.0	1.0
Concrete pit	3	20	11.0	5.0	1.0	4.0	1.0
Concrete flume (swine)	4	20	11.0	5.0	1.0	4.0	1.0
Concrete slats	5	10	16.0	10.0	1.0	4.0	1.0
Concrete settling basin	6	20	11.0	5.0	1.0	4.0	1.0
Concrete upground tanks	7	20	11.0	5.0	1.0	4.0	1.0
Concrete flume (beef)	8	20	11.0	5.0	1.0	4.0	1.0
Earthen settling basin	12	20	12.0	5.0	2.0	4.0	1.0
Earthen detention basin	12	20	12.0	5.0	2.0	4.0	1.0
Earthen storage basin	13	20	12.0	5.0	2.0	4.0	1.0
Lagoon	14	20	12.0	5.0	2.0	4.0	1.0
Diversion terrace	15	20	11.0	5.0	1.0	4.0	1.0
Grassed infiltration area	16	20	12.0	5.0	1.0	4.0	1.0

(continued)

TABLE 1 (continued)

Component	Component Number	Estimated Years Life	Assumed Annual Costs (% of original investment)				
			Total =	Depreciation +	Repairs and Maintenance +	Interest +	Insurance
Tractor scraper	26	10	18.0	10.0	3.0	4.0	1.0
Mechanical alleyway scraper	27	7	24.3	14.3	5.0	4.0	1.0
Mechanical cage scraper	28	7	24.3	14.3	5.0	4.0	1.0
Gutter cleaner	29	10	20.0	10.0	5.0	4.0	1.0
Gutter cleaner (elevator)	30	10	20.0	10.0	5.0	4.0	1.0
Gutter cleaner (stacker)	31	10	20.0	10.0	5.0	4.0	1.0
Stacker	32	10	20.0	10.0	5.0	4.0	1.0
Tractor scraper (poultry)	33	10	18.0	10.0	3.0	4.0	1.0
Front end loader	34	10	18.0	10.0	3.0	4.0	1.0
Tractor skid loader	35	7	24.3	14.3	5.0	4.0	1.0
Cage pan scraper	36	7	24.3	14.3	5.0	4.0	1.0
Box spreader (with storage)	41	10	20.0	10.0	5.0	4.0	1.0
Vacuum tank wagon	42	7	24.3	14.3	5.0	4.0	1.0
Tank wagon	43	7	23.3	14.3	4.0	4.0	1.0
Truck box spreader	44	7	24.3	14.3	5.0	4.0	1.0
Truck tank spreader	45	7	23.3	14.3	4.0	4.0	1.0
Injector	46	7	24.3	14.3	5.0	4.0	1.0
Box spreader (daily spread)	57	5	30.0	20.0	5.0	4.0	1.0

(continued)

TABLE 1 (continued)

Component	Component Number	Estimated Years Life	Assumed Annual Costs (% of original investment)				
			Total =	Depreciation +	Repairs and Maintenance +	Interest +	Insurance
Siphon Tank	51	10	18.0	10.0	3.0	4.0	1.0
Tipping Tank	52	7	24.3	14.3	5.0	4.0	1.0
Gated Tank	53	10	20.0	10.0	5.0	4.0	1.0
Recycle Pump	60	5	30.0	20.0	5.0	4.0	1.0
Piston Pump	61	7	23.3	14.3	4.0	4.0	1.0
Agitate/Load Pump	62	5	30.0	20.0	5.0	4.0	1.0
Irrigation System (waste)	66	7	24.3	14.3	5.0	4.0	1.0
Irrigation System (runoff)	67	10	19.0	10.0	4.0	4.0	1.0
Oxidation Ditch Rotor	71	4	35.0	25.0	5.0	4.0	1.0
Floating Aerator	72	5	29.0	20.0	4.0	4.0	1.0
Dehydrator	76	5	30.0	20.0	5.0	4.0	1.0
Pit Ventilation	81	5	30.0	20.0	5.0	4.0	1.0
Land	82	--	11.0	--	2.0	8.0	1.0

Pollution Control Scale

For individual livestock operations, some quantitative measurement of water quality coming off the lot and odor from the lot are possible. However, the degradation of stream and air quality is nearly impossible to measure. First, the amount of degradation is a function of the quality of the receiving waters and air. Therefore, not only must a measure of pollutants received by the stream and air be made, but also the background level of water and air quality needs to be made to have an accurate assessment of pollution potential. For example, runoff from livestock facilities may not be a problem near a stream of high flow and high water quality. However, that same level of runoff could be quite damaging to a stream at low flow already suffering from impaired water quality.

Second, quantities of pollutants leaving fields or lots are not damaging to water quality unless they reach surface or ground waters. It is possible that the feedlot operator using a buffer strip of grass below his feedlot may cause little water pollution even though runoff from the lot is substantial. Thus, quantitative measures must be made where the environmental burden actually occurs rather than at the lot or field.

Finally, the level of pollutants from any facility is a function of the climatic conditions. Quantitative measures of water or air pollution imply something about quality only at one point in time. Several measures through time are necessary to accurately assess damage.

Because of the complexities of measuring water and air parameters quantitatively, a qualitative measure has been developed for the quantity of water running off the facility, the quality of the water, and the level of odor near the facility. The following scale is used for these three parameters.

1	2	3	4	5
No Pollution				Severe Pollution

LIVESTOCK WASTE SYSTEMS USED

Each livestock operation is nearly unique in its complement of feeding, housing, and waste disposal systems. Certainly, similarities exist between operations for the same species,but the number of different waste disposal systems is large. When reviewing the literature, more discussion of "exotic" and advanced engineered systems is often found than of the systems actually in use on the majority of farms. For example, the oxidation ditch for swine is referred to regularly in the literature although its appearance on farms is uncommon. On the other hand, the common swine feeding operation using pasture or unpaved open lot construction with shelter is rarely mentioned.

The result of these two factors - uniqueness of systems and a dearth of information about those which are more common - makes the identification of benefits and costs of "typical" systems a challenging effort. Those systems identified in this analysis are those that the authors and others familiar with the industry feel to be representative of actual or potential systems for a large number of operations.

Systems to be discussed in the following sections are for dairy, fed beef, beef cow/calf herds, fed hogs, swine breeding, fed lambs, ewes/lamb flocks and poultry-layers, broiler and turkeys. Alternative systems for each species are noted. In discussing the benefits from the fertilizer nutrients in livestock wastes, the nutrients are valued according to the quantities available to crops. The cost of pollution control alternatives is presented for the various systems.

SECTION 6

DAIRY WASTE MANAGEMENT OPTIONS

The trend in dairy production has been toward fewer farms and fewer total cows, but higher producing cows and larger herds. For the 10-year period from 1964 to 1974, herds of 10 or more cows were reduced by 40% (Hoglund, 1975).

It is difficult to regionally distinguish waste handling systems. Within a state the waste systems vary due to nearness to urban areas, cropping practices, climate, farmers' preference, etc. For example, waste handling in California varies from the southern part of the State with very large cow herds using a dry lot to the northern high rainfall Humbolt area with small herds using stall barns and conventional manure systems.

An additional constraint on selection of waste handling systems is that of milk sanitation. For Class A milk production, control of odors and flies, and cow cleanliness as related to manure handling must be considered. This constraint causes a higher annual cost per animal for the dairy manure systems than for other livestock.

Factors affecting dairy waste system selection in addition to climate, topography, soils, etc. are type of housing, feeding regime, animal type and herd size. The type of housing will be a major factor in determining whether the manure will be handled as a solid or a liquid (slurry). Cows in the dairy industry may be divided into two classes: milking and dry cow/replacement heifers. In many cases the manure system for the dry cow/replacement heifer herd is part of the total dairy operation. However, for the larger herds, frequently the dry cow/replacement heifers are removed from the milking herd and housed at another location with a separate waste system. The same manure system selection criteria and constraints apply to the replacement herd's manure system.

The following section describes various dairy waste systems which are analyzed for costs in a later section. Regional aspects of the various manure systems are noted. In all the systems illustrated there is a storage structure shown. This storage structure is a pollution control feature. Many dairy farmers continue to haul and spread manure on a daily basis and do not use manure storage. Other pollution control components that will be analyzed for costs are rainfall runoff control and odor control by soil incorporation.

WASTE SYSTEMS

The housing facility in the cold humid, cool humid, and warm humid regions typically provides housing for the cows during the winter months. The cows may be fed inside the barn or in a feedbunk on a lot adjacent to the barn. Frequently a paved lot may be provided for exercising the cattle. Wherever there is an open lot area for cattle, a provision for runoff control is evaluated for pollution control. The decision to totally house the cows may in itself be a pollution control feature.

A free stall barn with the cows being fed on an outside paved lot is shown in Figure 12. Cows are allowed to move in and out freely. The waste system depicted in this figure is a free stall, tractor scrape, piston pump and earthen storage basin. The earthen storage basin is usually designed for a minimum of 12 months storage. Runoff control is obtained in Figure 12 by curbing the outside paved lot and channeling the runoff into the storage basin. For a large feedlot area it may be desirable to use a settling basin and a grassed infiltration area instead of channeling the runoff into the storage basin. Scraping of the outside paved lot may be restricted in cold humid areas due to freezing of accumulated manure. Milking facility wastewater would typically be pumped to the storage basin. An alternative to the piston pump would be a push-off ramp extending out over the storage basin, or a vertical, concrete abutment at the edge of the basin.

A free stall dairy barn is shown in Figure 13. In some areas of limestone rock or soils unsuitable for an earthen storage basin, the above ground concrete or treated steel tank (silo) is the storage component. By using a mechanical alley scraper and cross-gutter cleaner with the piston pump, manure removal can be automated.

When the farmer chooses to handle his free stall manure in the solid form a treated plank walled structure, as shown in Figure 14, can be used. The roof over the storage structure is optional. At facilities with an outside lot that have runoff control components, the farmer may choose not to roof the storage area.

A confinement stall barn is shown in Figure 15 with the conventional gutter cleaner. A manure spreader is being loaded directly by the gutter cleaner/elevator. This method for daily hauling is typical of many small dairy farms. In order to provide additional storage the farmer may choose to use a stacker (elevator). The stacker may be fixed at one point or provision for moving it in an arc can be made, as shown in the insert. The stored manure is loaded into a box spreader for land application.

The use of a concrete manure storage tank,as shown in Figure 16, is one of the earlier liquid handling systems. The concrete tank is located under the floor of the building. A variation of this system is to have slotted floor alleyways with the storage pits beneath the slats.

The previous illustrations of dairy manure management systems are typical of those in humid and cooler climates. In the warm humid, hot humid,

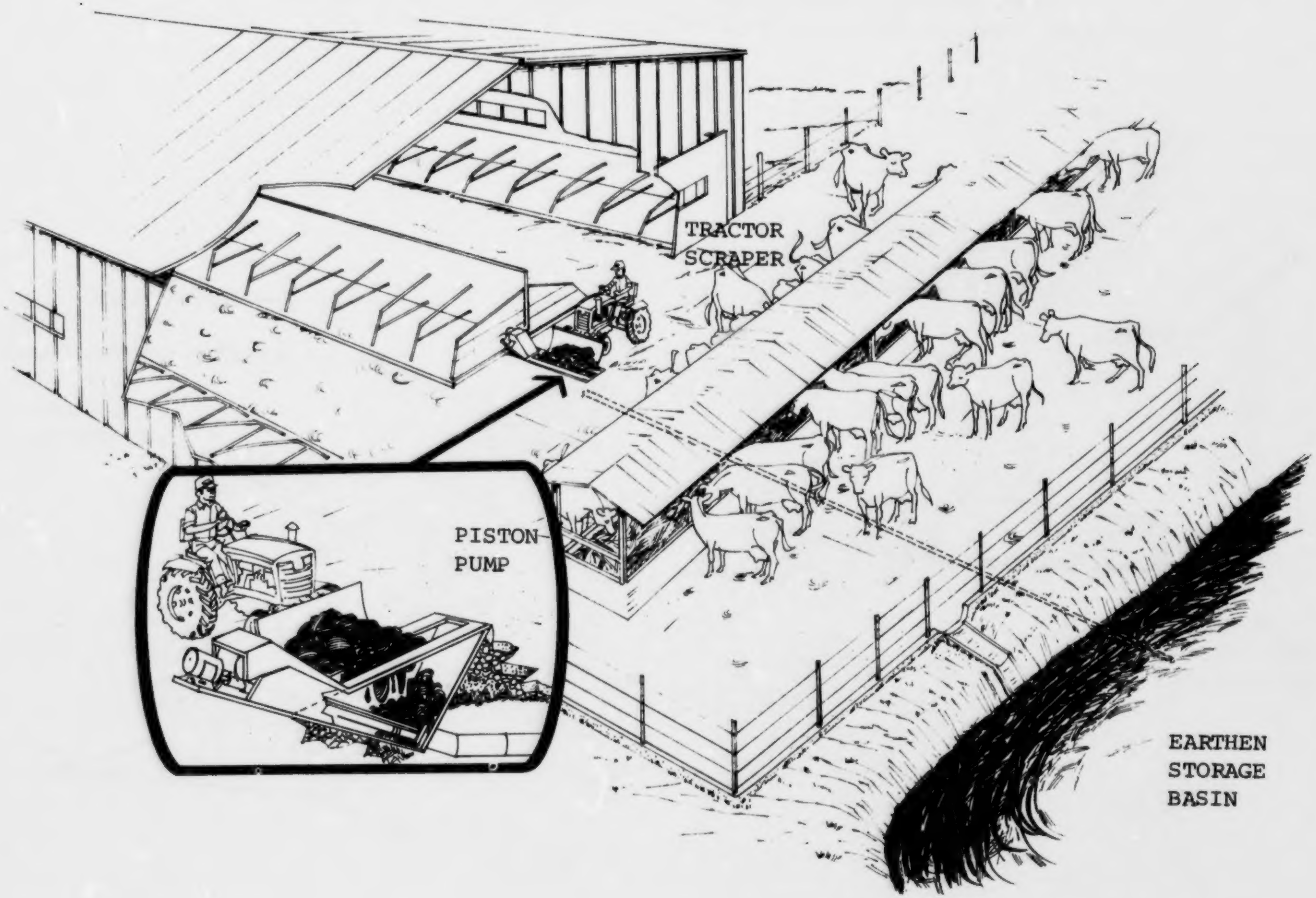
TRACTOR
SCRAPER
PISTON
PUMP
EARTHEN
STORAGE
BASIN

Figure 12. Free stall dairy barn with tractor scraper, piston pump and earthen storage basin waste system.

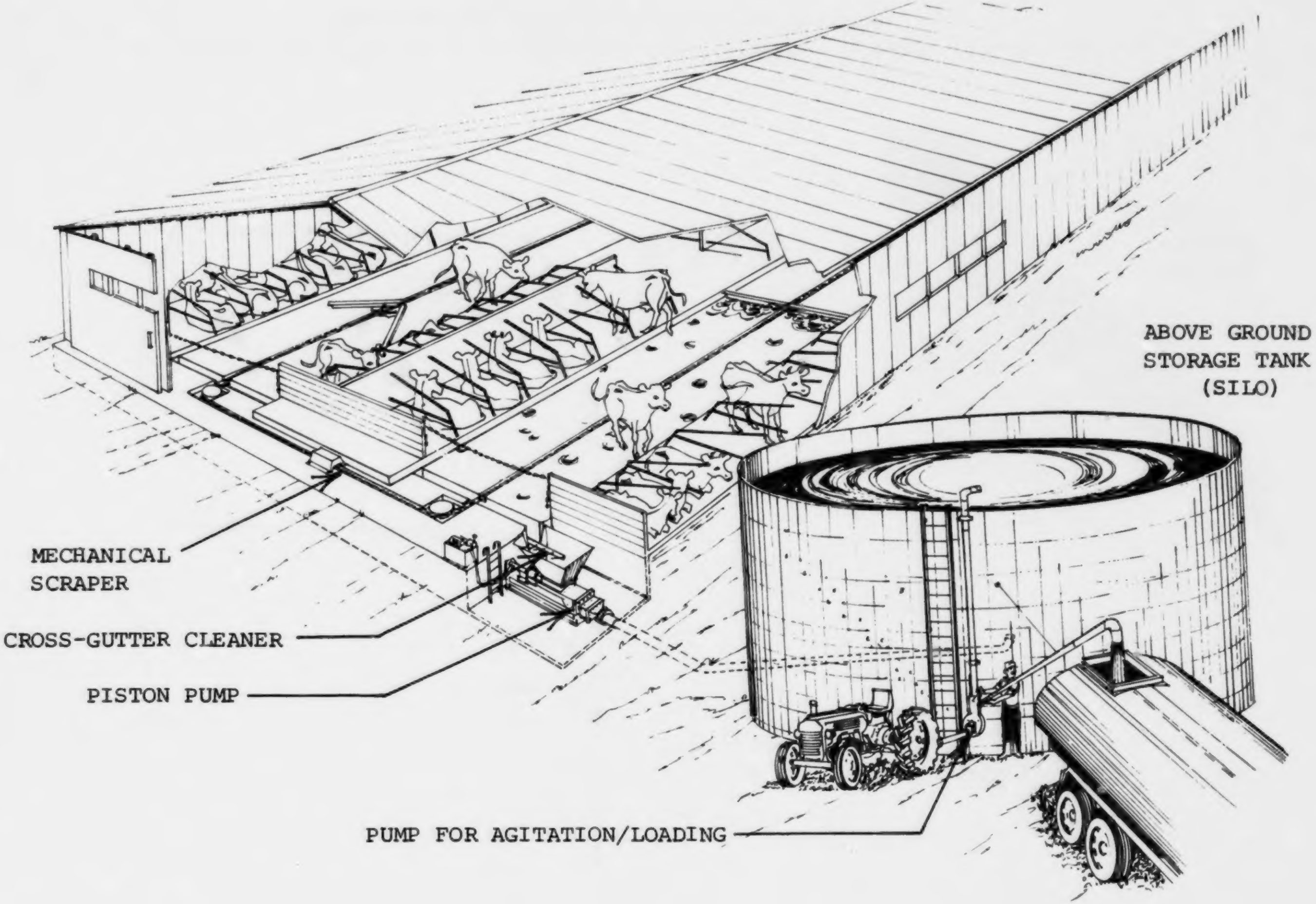
ABOVE GROUND
STORAGE TANK
(SILO)
MECHANICAL
SCRAPER
CROSS-GUTTER CLEANER
PISTON PUMP
PUMP FOR AGITATION/LOADING

Figure 13. Free stall dairy barn with mechanical alley scraper, cross-gutter cleaner, piston pump and upground storage tank.

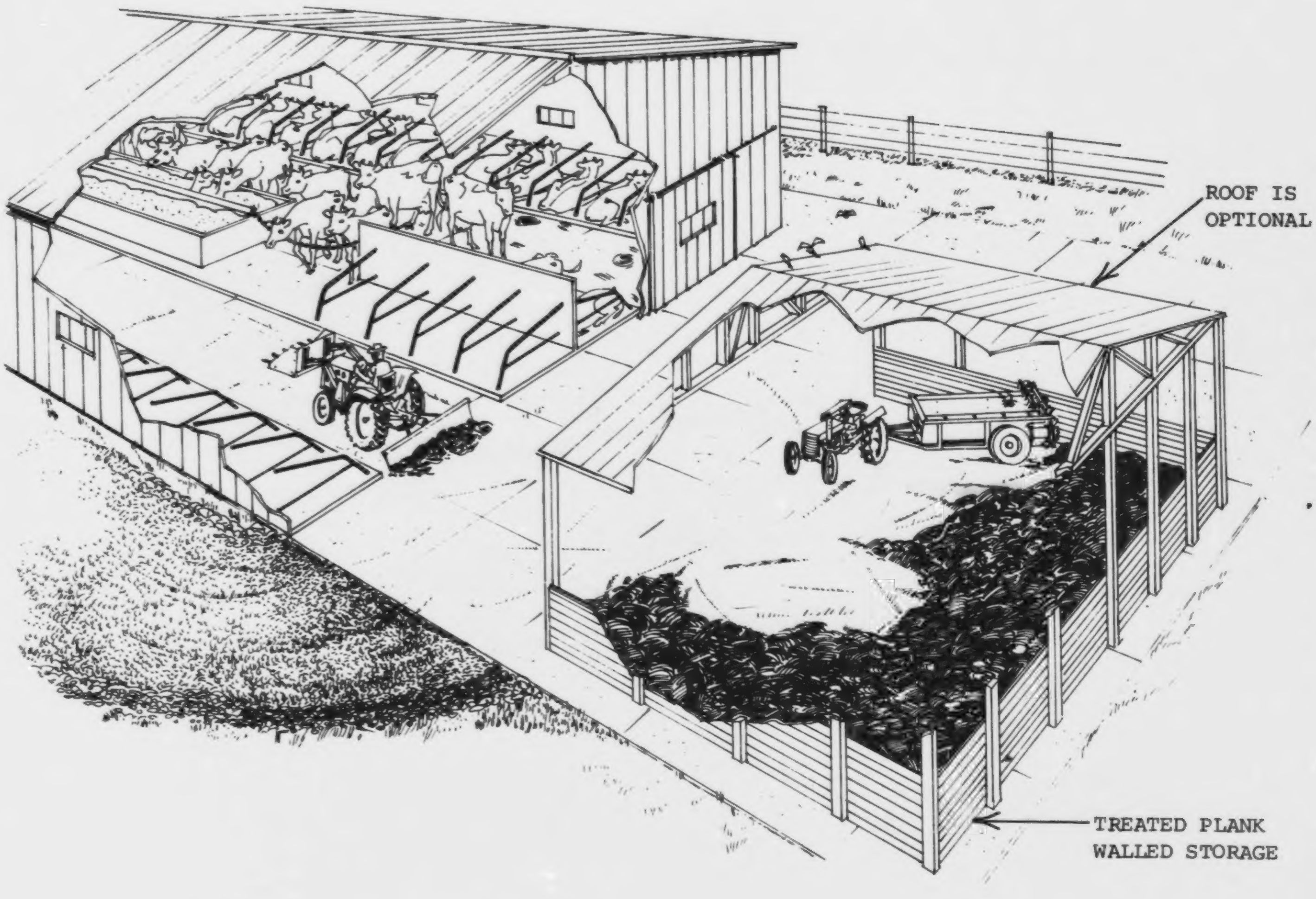
ROOF IS
OPTIONAL
TREATED PLANK
WALLED STORAGE

Figure 14. Free stall dairy barn with tractor scrape, upground plank walled storage and box spreader for solid handling.

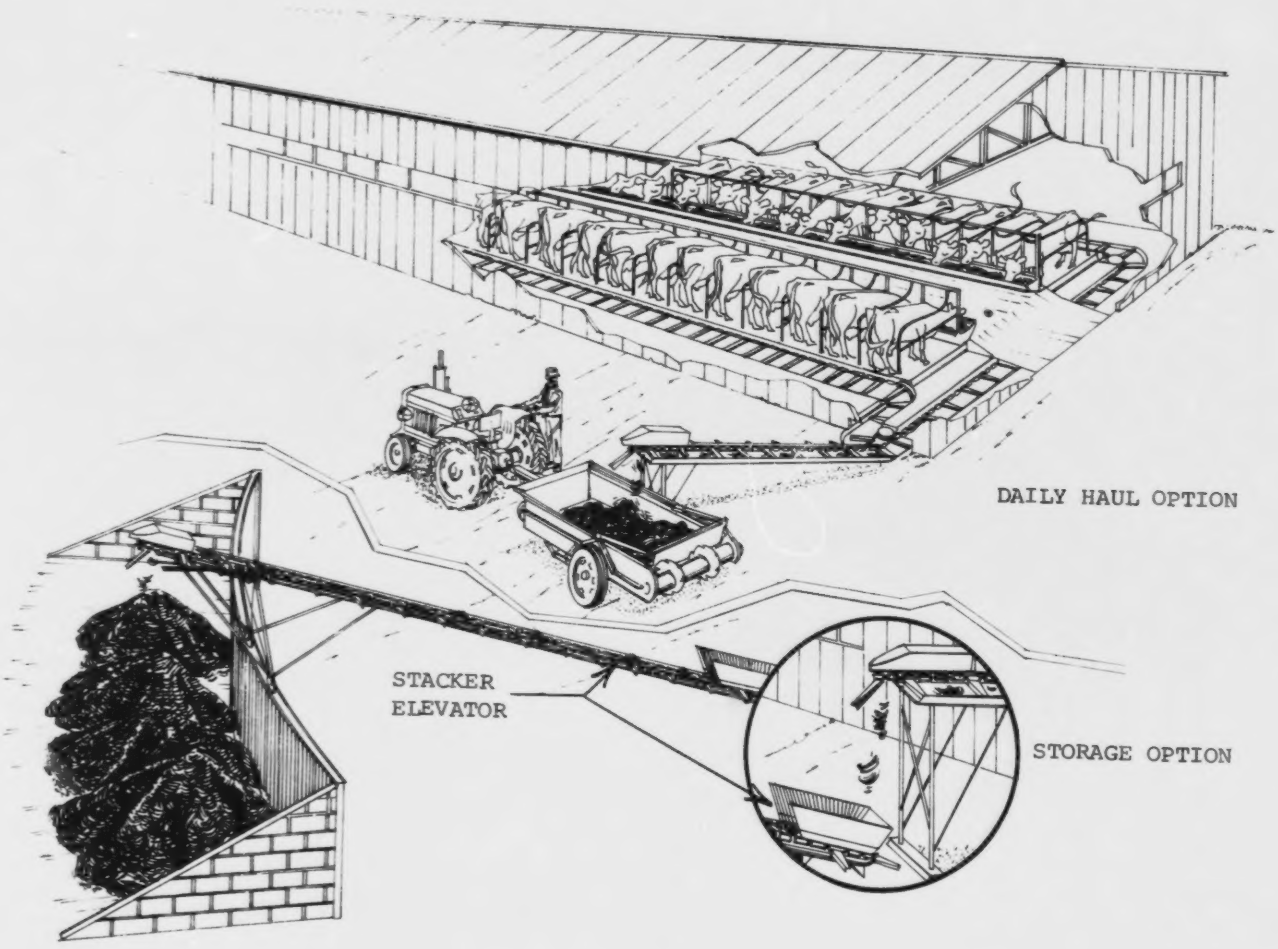
DAILY HAUL OPTION
STACKER ELEVATOR
STORAGE OPTION

Figure 15. Confinement dairy barn with conventional gutter cleaner or elevator (stacker) and concrete pad storage.

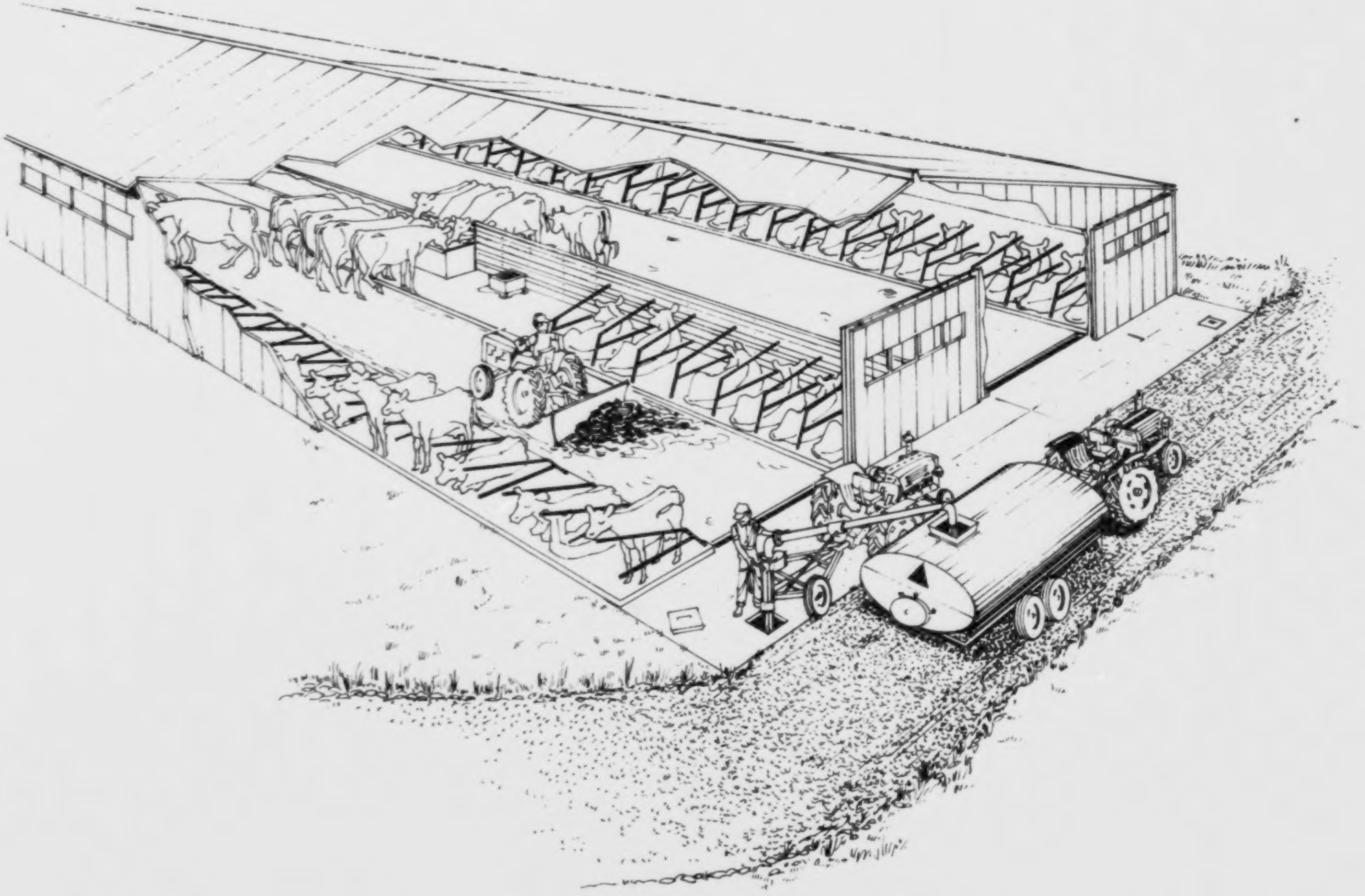

Figure 16. Free stall dairy barn with tractor scrape, below ground storage tank, agitation/loading pump and tank wagon for liquid spreading.

and warm arid parts of the United States, a flushing system with treatment lagoons may be used. A dairy facility where the alleyways are flushed to a cross-gutter is shown in Figure 17. The wastewater then flows to a two-stage lagoon. Flush water is recycled from the second lagoon. Management of the lagoons requires yearly irrigation to control the dissolved salts in the lagoon wastewater and periodic (3 to 5 years) sludge removal.

In warm arid, hot arid, and hot humid areas, the unpaved open lot may be used (Figure 18). Manure is scraped from the feedlot and stockpiled or hauled directly to cropland. Runoff control is needed for the few rainstorms that do occur. Usually a detention basin with controlled irrigation is used. Odors and dusts can be a problem from these dairy feedlots.

OPTIONS TO BE ANALYZED

The trend in dairy herds is towards total confinement and larger sizes. The dairy systems to be analyzed are confined systems and open lot systems for milking cows. Also, dry cow and replacement heifer facilities are discussed.

Milking Cows, Confined Free Stall

The confinement of cattle to an area which is unexposed to rainfall means that runoff from the lot surface is effectively controlled. However, runoff from cropland may result when the manure is spread.

Benefits and costs for the farmer are computed for the following confined free stall systems. The systems are located primarily in cold humid, cool humid, and warm humid areas as delineated in Figure 1.

1. Tractor scrape
   (a) base system, daily spread
   (b) base system with 6 months plank storage

2. Tractor scrape, concrete pit storage (6 months)
   (a) base system
   (b) base system, manure plowdown

3. Slotted floor, concrete pit storage (6 months)
   (a) base system
   (b) base system, manure plowdown

4. Mechanical scrape, piston pump, earthen storage (6 months)
   (a) base system
   (b) base system, manure plowdown

5. Mechanical scrape, piston pump, silo storage (6 months)
   (a) base system
   (b) base system, manure plowdown

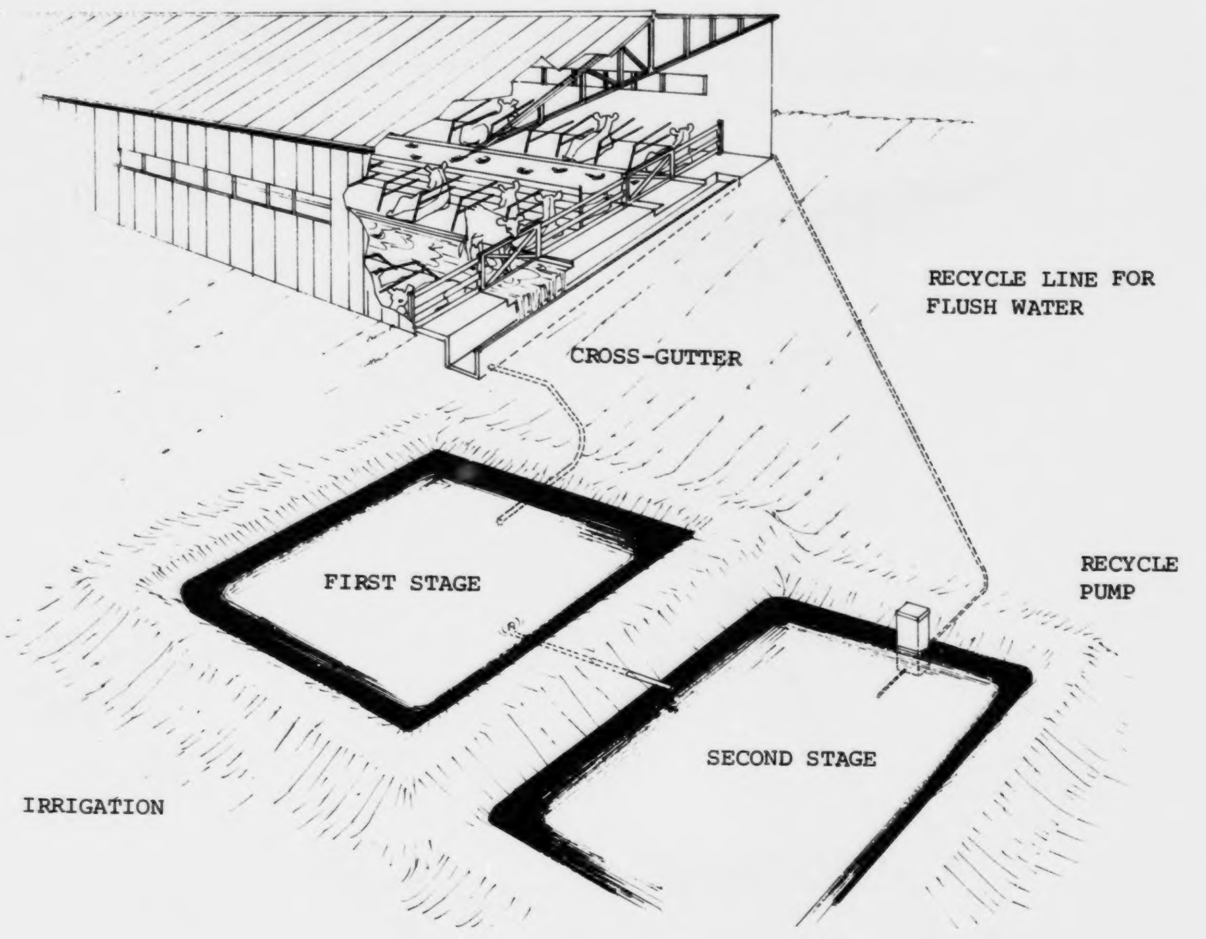
RECYCLE LINE FOR FLUSH WATER
CROSS-GUTTER
FIRST STAGE
RECYCLE PUMP
SECOND STAGE
IRRIGATION

Figure 17. Flushing free stall alleyways to a two-stage lagoon treatment system.

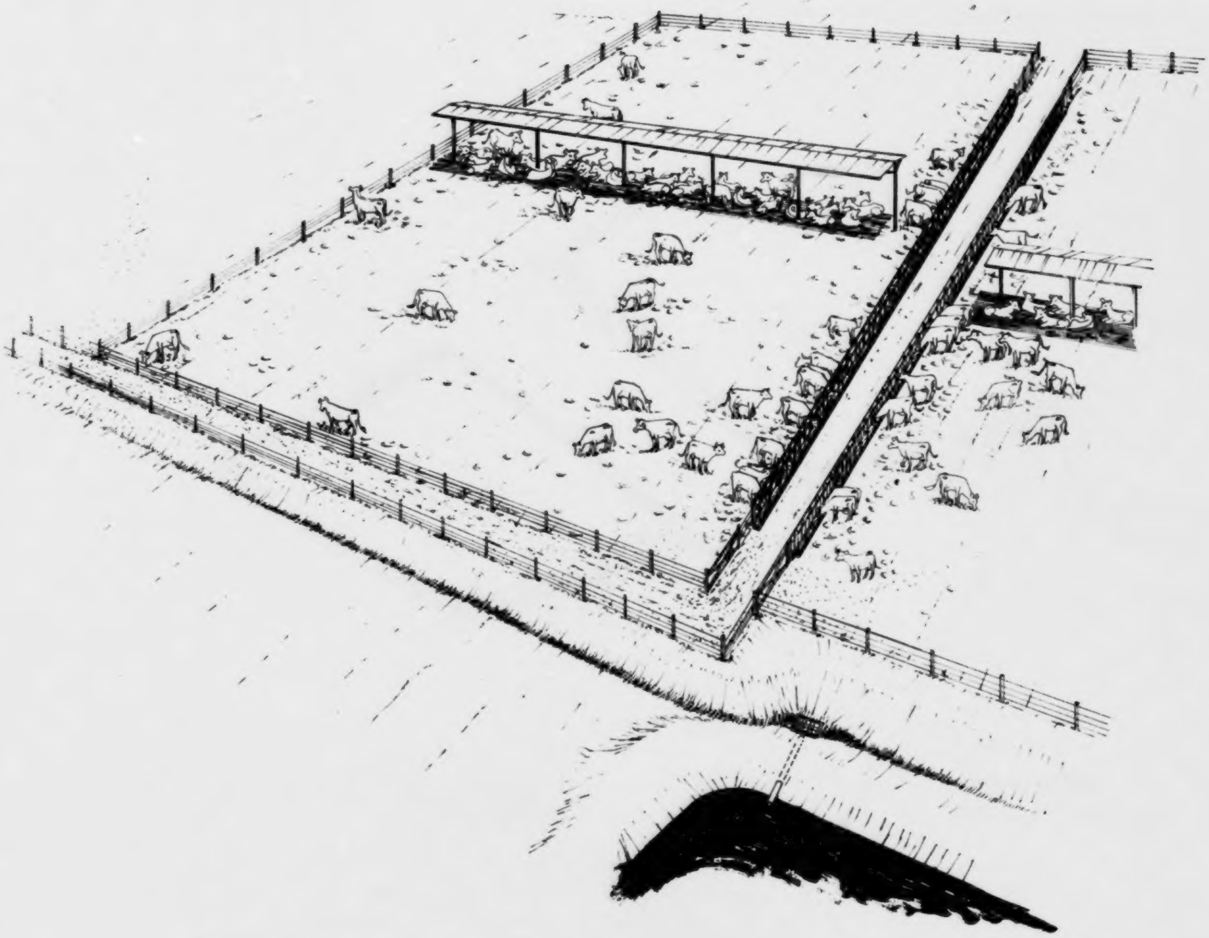

Figure 18. Dry-lot dairy system common to hot arid and warm arid regions. Manure is periodically scraped from lot.

6. Mechanical scrape, concrete pit storage (6 months)
   - (a) base system
   - (b) base system, manure plowdown

Milking Cows, Confinement Stall

Another type of confined system is the confinement stall system where dairy animals are restricted to individual stalls. These systems are found primarily in the cool humid and cold humid regions delineated in Figure 1.

Gutter cleaner with elevator or stacker
- (a) base system, daily spreading
- (b) base system, 6 months above ground concrete storage
- (c) base system, 6 months above ground concrete storage, and plowdown
- (d) base system, 6 months plank storage
- (e) base system, 6 months plank storage, and plowdown

Milking Cows, Open Lot, Free Stall

Used in the cool humid, warm humid, and hot humid areas, this system permits cattle access to an exposed open lot area as well as an enclosed free stall barn. Thus, control of lot runoff is a pollution control modification for the system.

1. Tractor scrape, solid spreading
   - (a) base system
   - (b) base system with diversion, settling basin, and grass infiltration area
   - (c) base system with diversion, settling basin, lagoon, and wastewater irrigation

2. Tractor scrape, piston pump, earthen storage
   - (a) base system
   - (b) base system with plowdown

Milking Cows, Confined Free Stall Flush

Limited primarily to warm arid, warm humid and hot humid areas, this system is found on lots with large numbers of dairy cows. When the system is located in arid regions, the effluent is often metered into an existing irrigation line.

1. Flush, anaerobic lagoon (6 month storage)
   - (a) base system
   - (b) base system with solid separation

2. Flush, earthen storage (limited storage is provided)

Milking Cows, Pasture Year-Round, Flush

Animals are confined to an unpaved open lot with shade provided. This system is used in warm arid, hot arid, and hot humid climates.

Tractor scrape, solid spreading
(a) base system
(b) base system with diversion, settling basin,
detention or evaporation basin

In summary, the primary form of pollution control needed is handling rainfall runoff. Two methods of controlling rainfall runoff are: diversion terrace-settling basin-detention basin-irrigation system and diversion terrace-settling basin-grassed infiltration area. Other forms of pollution control are (1) storage to alleviate the need for daily spreading, and (2) soil incorporation to control odor nuisance from field spreading.

Dry Cows/Heifers--

On most dairy farms, the dairy heifer production is tied closely with the dairy cow system. Confined free stall, confinement stall, open lot free stall, pasture, and unpaved open lot systems with all the variations described earlier pertain to replacement herd as well as the milking herd.

While the structure of the systems is basically the same for heifers as for cows, costs and benefits from disposal systems will change slightly. Waste production would be less for heifers, thus benefits would be reduced. Labor and tractor requirements for hauling, scraping, and spreading also would be reduced due to the smaller volume of waste hauled. On the other hand, most of the capital investments would be similar. Animal densities are approximately the same for heifers as cows, and equipment and structures require about the same investment.

Due to the similarities of replacement herd and milking herd benefits and costs, system estimates are not made for dry cows and heifers. Those interested in estimates for farms with dry cows and heifers can refer to the basic dairy cow systems, and assume that size designations refer to numbers of animal units rather than number of cows.

ECONOMIC ANALYSIS

For dairy as well as the other major livestock species, the benefits and costs of alternative waste systems are described. The organization of the analysis is designed to (a) estimate farmers' returns and costs for alternative systems, (b) qualitatively estimate society costs in terms of water and air quality, and (c) depict the tradeoffs between the costs to farmers and society of pollution control technology and the benefits of improved water and air quality.

Benefits from Waste

Quantities of nutrients in dairy waste depend on animal size, species, feed ration, and climate. For the purpose of this analysis, it is assumed that one dairy animal is 1400 pounds and produces annually 210 pounds of nitrogen, 84 pounds of phosphate (P_2O_5), and 166 pounds of potash (K_2O).

Nitrogen losses occur in storage, handling, and spreading. Soil incorporation of manure by plowdown or injection reduces losses of nitrogen as compared to surface spreading. Handling manure by a flush system, storing in a lagoon, and irrigating can lead to significant nitrogen losses (Table 2).

Phosphate and potash losses are less affected by storage, handling, and spreading than are nitrogen losses. Generally, a high proportion of phosphate and potash is available to the plant regardless of the waste management system. An exception is the liquid flush, lagoon, and irrigated systems where substantial losses occur.

Even though nutrients are available after storage, handling, and spreading, valuing all the remaining nutrients as benefits is erroneous in some regions. Cropland may not be available for manure application, and it is applied to crops or grass which does not fully utilize the available nutrients. Thus, in computing benefits, two levels of nutrient return have been assumed. One level assumes that 100 percent of all available nutrients (after storing, handling, and spreading losses have been discounted) are utilized by the crops. The second level assumes that only 50 percent of available nutrients is utilized by the crops. Nutrient prices used in the calculation are $0.16 per pound for nitrogen, $0.18 per pound for phosphate, and $0.10 per pound for potash. These prices and the resulting benefits may need to be adjusted by users for their particular region.

Analysis of Options

Confined Free Stall--

Several variations of this basic system are analyzed and shown in Tables 3, 4 and 5: (1) tractor scrape, daily spread, (2) tractor scrape, plank storage (6 month), (3) tractor scrape, pit storage [6 month], (4) slotted floor, pit storage [6 month], (5) mechanical scrape, piston pump, earthen storage, (6) mechanical scrape, piston pump, silo storage, and (7) mechanical scrape, concrete pit storage. For (1) tractor scrape, daily spreading, the pollution control alternative is assumed to be earthen storage. For the other free stall systems with storage already in place [systems (2), (3), (4), (5), (6), and (7) above], plowdown of manure is the pollution control modification available.

The basic free stall system of tractor scrape and daily spread [system (1) above] is relatively inexpensive. For the 100 head unit, annual net system costs are $31.04 per head (Table 3) and are $20.93 per head for the 200 head units. However, annual net system costs escalate as mechanical scrapers and/or various types of storage are added. For example, adding a concrete pit to the basic system [system (3) above] increases annual net system costs to $73.00 per animal year for the 100 head herd (Table 3). Adding a concrete pit with mechanical scrape [system (7) above] to the basic system increases annual net system costs to $109.48 per animal year for the 100 head herd (Table 5).

The annual net system costs increase as additional capital investments in scraping and storage are added to the free stall system, as seen in

TABLE 2. NITROGEN, PHOSPHATE (P_2O_5) AND POTASH (K_2O) AVAILABLE TO CROPS FROM DAIRY WASTE PER ANIMAL UNIT[a] FOR ALTERNATIVE HANDLING SYSTEMS

System	Nutrients Available to Crops per Animal Unit[b] (lbs/yr)		
	Nitrogen	Phosphate (P_2O_5)	Potash (K_2O)
Solid handling, daily spread	124	76	149
Solid handling, uncovered storage, surface spread	143	76	141
Solid handling, covered storage, soil incorporated[c]	179	76	149
Solid handling, uncovered storage, soil incorporated[c]	170	76	141
Solid handling, storage in loafing shed, surface spread	107	76	141
Liquid handling, storage, surface spread	116	76	149
Liquid handling, storage, soil incorporated[c]	149	80	158
Liquid, flush, lagoon, irrigate	32	42	100
Liquid, flush, solid separation, lagoon, irrigate	26	34	80
Solid handling, open lot storage, surface spread	76	71	141

[a] One animal unit = 1400 lb cow.

[b] Average assumed production from 1400 lb cow:
nitrogen per animal year = 210 lbs,
phosphate (P_2O_5) per animal year = 84 lbs, and
potash (K_2O) per animal year = 166 lbs.

[c] Injected or plowed down the day of spreading.

TABLE 3. DAIRY, CONFINED FREE STALL, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS USING TRACTOR SCRAPING[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients: 50 Percent Usage of Available Nutrients (4)	Returns to Nutrients: 100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	Net System Returns: At 50 Percent Usage of Nutrients (4)-(6)-(7)	Net System Returns: At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Tractor scrape, daily spread	Surface spread	50	24.21	48.42	67.06	31.71	-74.56	-50.35	A-1
	Surface spread	100	24.21	48.42	54.30	25.15	-55.24	-31.04	A-2
	Surface spread	200	24.21	48.42	50.49	18.86	-45.14	-20.93	A-3
Tractor scrape, plank storage (6 month)	Surface spread	50	25.73	51.46	67.06	47.94	-89.27	-63.54	A-4
	Surface spread	100	25.73	51.46	49.40	40.15	-63.82	-38.09	A-5
	Surface spread	200	25.73	51.46	44.70	32.15	-51.12	-25.39	A-6
Tractor scrape, pit storage (6 month)	Surface spread	50	23.57	47.14	69.23	73.36	-119.02	-95.45	A-7
	Plowdown	50	27.02	54.04	69.23	73.36	-115.57	-88.55	A-8
	Surface spread	100	23.57	47.14	63.88	56.25	-96.57	-73.00	A-9
	Plowdown	100	27.02	54.04	63.88	56.25	-93.12	-66.10	A-10
	Surface sprea	200	23.57	47.14	46.59	44.11	-67.13	-43.56	A-11
	Plowdown	200	27.02	54.04	46.59	44.11	-63.68	-36.66	A-12

[a] These systems are located primarily in cold humid, cool humid, and warm humid regions

TABLE 4. DAIRY, CONFINED FREE STALL, ANNUAL RETURNS AND COSTS FOR SLOTTED FLOOR ALTERNATIVE[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients: 50 Percent Usage of Available Nutrients (4)	Returns to Nutrients: 100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	Net System Returns: At 50 Percent Usage of Nutrients (4)-(6)-(7)	Net System Returns: At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Slotted floor, pit storage (6 month)	Surface spread	100	23.57	47.14	43.10	83.30	-102.83	-79.26	A-13
	Plowdown	100	27.02	54.04	43.10	83.30	-99.38	-72.36	A-14

[a] These systems are located primarily in cold humid, cool humid, and warm humid regions.

TABLE 5. DAIRY, CONFINED FREE STALL, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS USING MECHANICAL SCRAPING[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients		Variable Costs (6)	Fixed Costs (7)	Net System Returns		Appendix Reference
			50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)			At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	
				(Dollars per Animal Year)					
Mechanical scrape, piston pump, earthen storage	Surface spread	50	23.57	47.14	68.99	97.21	-142.63	-119.06	A-15
	Plowdown	50	27.02	54.04	68.99	97.20	-139.17	-112.15	A-16
	Surface spread	100	23.57	47.14	53.16	56.40	- 85.99	- 62.42	A-17
	Plowdown	100	27.02	54.04	53.16	56.40	- 82.54	- 55.52	A-18
	Surface spread	200	23.57	47.14	39.21	44.13	- 59.77	- 36.20	A-19
	Plowdown	200	27.02	54.04	39.21	44.00	- 56.19	- 29.17	A-20
Mechanical scrape, piston pump, silo storage (3 month)	Surface spread	100	23.57	47.14	40.33	71.49	- 88.25	-64.68	A-21
	Plowdown	100	27.02	54.04	40.33	71.49	- 84.80	-57.78	A-22
Mechanical scrape, pit storage (6 months)	Surface spread	100	23.57	47.14	57.76	98.86	-133.05	-109.48	A-23
	Plowdown	100	27.02	54.04	57.76	98.86	-129.60	-102.58	A-24

[a] These systems are located primarily in cold humid, cool humid and warm humid regions.

Figure 19. From the farmer's point of view, storage is costly. However, if storage is chosen as part of the free stall, confinement system, plowdown or soil incorporation becomes a way of easing the extra cost burden. For those systems already having storage, manure plowdown returns approximately $7 per animal year. For example, annual net system costs for the tractor scrape, pit storage system [system (3) above] decline from $73.00 to $66.10 per animal year when surface spreading is replaced by plowdown for the 100 head herd (Table 3). Similar cost reductions of about $7 per animal unit are seen in the mechanical scrape systems (Table 5) and the slotted floor system (Table 4) as plowdown is substituted for surface spreading.

Confinement Stall--

The benefits and costs of the confinement stall systems are shown in Table 6. All systems use gutter cleaners with (1) daily spreading, (2) plank storage with stacker, or (3) above ground concrete storage with solid head piston pump. The method of pollution control for those systems with storage is soil incorporation by plowdown.

Annual net system costs tend to be slightly lower than the confined free stall systems. For the 100 cow herd using the confinement stall, gutter cleaner system with no storage, annual net system costs are $33.45 per animal year. Adding plank storage results in annual net system costs of $47.66 per animal year; however, adding plank storage plus plowdown reduces annual net system costs to $43.34 due to more nutrients available.

The above ground concrete storage with piston pump [system (3) above] is relatively expensive for the 50 cow herd with net system costs of $92.26 per animal year. However, the system becomes competitive with other confinement stall systems for the 100 cow herd. Here net system costs are $45.38 per animal year and $38.82 with plowdown (Table 6).

The annual net system costs for confinement stall systems with daily spreading, with concrete and plank storage and plowdown are shown in Figure 20. The confinement stall system with no storage or plowdown is unusual in that nearly constant returns to size are exhibited rather than the economies of size in other systems.

Free Stall Open Lot--

The free stall open lot waste system has two basic variations - daily spreading and storage. The estimates for this system with its variations are shown in Tables 7 and 8. With the open lot daily spreading system, the methods of pollution control for runoff are the grass infiltration or the detention/irrigation systems. For the open lot system with storage, pollution control is by plowdown of stored manure and runoff control.

Differences in annual net system costs for free stall open lot systems are substantial, ranging from $20.00 per animal year for the 100 cow unit with daily spreading and no runoff control to $67.63 per animal year for the 100 cow unit with earthen storage with surface spreading. Furthermore, these differences would be larger if all the numerous types of storage systems (concrete above ground, concrete pit, etc.) were included. Most of these differences are attributable to differences in fixed costs associated with

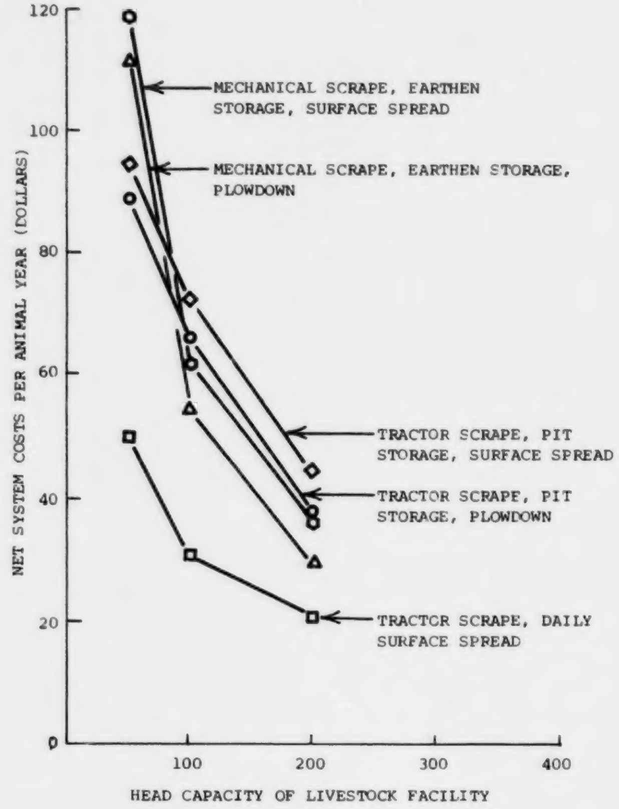

Figure 19. Dairy, annual net system costs for confined free stall (100% utilization of available nutrients assumed).

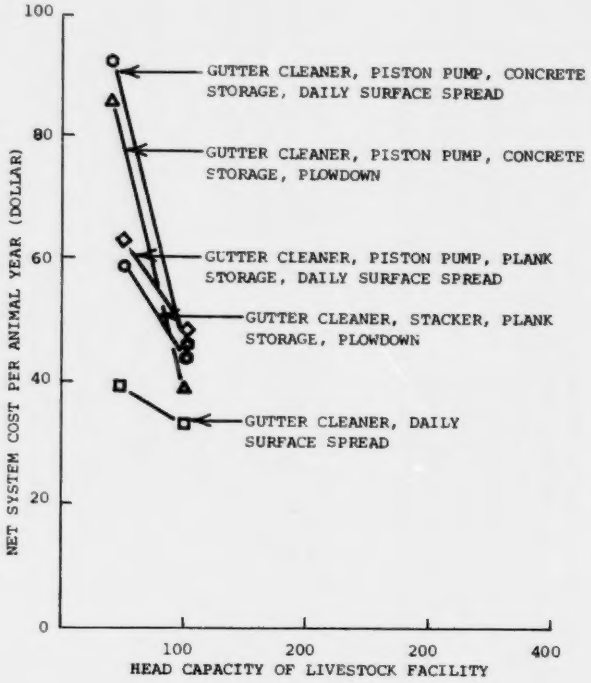

Figure 20. Dairy, annual net system costs for confinement stall (100% utilization of available nutrients assumed).

TABLE 6. DAIRY, CONFINEMENT STALL, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients: 50 Percent Usage of Available Nutrients (4)	Returns to Nutrients: 100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	Net System Returns: At 50 Percent Usage of Nutrients (4)-(6)-(7)	Net System Returns: At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Gutter cleaner, daily spread	Surface spread	50	24.21	48.42	47.12	40.54	-63.44	-39.23	A-25
	Surface spread	100	24.21	48.42	46.05	35.82	-57.66	-33.45	A-26
Gutter cleaner, stacker, plank storage (6 month)	Surface spread	50	25.73	51.46	39.53	74.60	-88.40	-62.67	A-31
	Plowdown	50	27.89	55.78	39.53	74.60	-86.24	-58.35	A-32
	Surface spread	100	25.73	51.46	36.30	62.03	-73.39	-47.66	A-33
	Plowdown	100	27.89	55.78	36.30	62.03	-71.23	-43.34	A-34
Gutter cleaner, piston pump, concrete storage (6 month)	Surface spread	50	25.33	50.66	40.31	102.61	-117.59	-92.26	A-27
	Plowdown	50	28.61	57.22	40.31	102.61	-114.31	-85.70	A-28
	Surface spread	100	25.33	50.66	19.44	76.60	-70.71	-45.38	A-29
	Plowdown	100	28.61	57.22	19.44	76.60	-67.43	-38.82	A-30

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[a] These systems are located primarily in cool humid and cold humid regions.

TABLE 7. DAIRY, FREE STALL OPEN LOT, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS WITHOUT STORAGE[a]

			Returns to Nutrients				Net System Returns		
Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Tractor scrape, daily spread, surface spread	Base	50	24.21	48.42	48.36	32.48	-56.62	-32.41	A-35
	Runoff control-infiltration	50	24.21	48.42	48.80	34.10	-58.69	-34.48	A-36
	Runoff control-detention	50	24.21	48.42	50.14	44.24	-70.17	-45.96	A-37
	Base	100	24.21	48.42	42.50	25.93	-44.21	-20.00	A-38
	Runoff control-infiltration	100	24.21	48.42	42.82	27.20	-45.82	-21.61	A-39
	Runoff control-detention	100	24.21	48.42	43.62	33.04	-52.45	-28.24	A-40
	Base	200	24.21	48.42	29.99	19.10	-24.87	- 0.66	A-41
	Runoff control-infiltration	200	24.21	48.42	30.15	20.94	-26.88	- 2.67	A-42
	Runoff control-detention	200	24.21	48.42	31.17	24.01	-30.97	- 6.76	A-43

[a] These systems are located primarily in cool humid, warm humid, and hot humid regions.

TABLE 8. DAIRY, FREE STALL OPEN LOT, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS WITH STORAGE[a]

Waste Management System (1)	System Modification (2)	Herd Size Head (Capacity) (3)	Returns to Nutrients		Variable Costs (6)	Fixed Costs (7)	Net System Returns		Appendix Reference
			50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)			At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	
					(Dollars per Animal Year)				
Tractor scrape, piston pump, earthen storage	Surface spread	100	23.57	47.14	52.38	62.38	-91.20	-67.63	A-44
	Plowdown	100	27.02	54.04	52.38	62.38	-87.74	-60.72	A-45
	Surface spread	200	23.57	47.14	43.34	31.19	-50.96	-27.39	A-46
	Plowdown	200	27.02	54.04	43.34	31.19	-47.51	-20.49	A-47

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[a] These systems are located primarily in cool humid, warm humid, and hot humid regions.

storage and runoff systems. The variable costs and returns to nutrients are similar for each of the free stall open lot systems, but the fixed costs change dramatically.

Net system costs are illustrated in Figure 21 for the free stall open lot systems. Obvious implications are that storage and controlling runoff are expensive to farmers. Storage adds approximately $47.00 per animal year to the annual net system cost of a 100 cow herd, and controlling runoff with the detention/irrigation system adds costs of $8 per animal year for the 100 head herd.

Another implication visualized in Figure 21 is that if storage is used, soil incorporation of the waste is beneficial to the farmer. Although soil incorporation benefits in terms of increased nutrient availability are approximately $7 per animal year, it can be used regularly only when storage is available. The daily spreading operation faces too many adverse soil conditions to allow regular soil incorporation.

Confined Free Stall, Wastewater Irrigation--

This large-scale system designed for the hot humid, warm humid, and warm arid regions has relatively low costs due to the economies of size enjoyed by larger herd sizes. Annual net system costs for the flush, lagoon system are $12.52 per head for the 200 head facility and $7.29 per head for the 500 head facility (Table 9). This basic system provides reasonably complete pollution control with no additional storage required.

System modifications include installation of temporary earthen storage rather than longer term lagoon. Using the earthen storage system allows the wastewater to be flushed from the free stall facility and applied immediately to the land. Added nutrients are available to crops and fixed costs are lower due to the lower investment in storage. Annual net system returns are $15 per animal year for the 200 head lot and $19 per animal year for the 500 head lot (Table 9).

Another system modification of the basic flush, lagoon, irrigate system is the addition of solids separation. Annual net system costs are increased to $28.04 per animal year for the 200 head lot and $18.31 per animal year for the 500 head lot (Table 9). Figure 22 shows economies of scale for these systems and modifications.

Pasture Year-Round, Lagoon, Irrigate--

Another large-scale system for the hot humid, warm humid, and warm arid regions, this system enjoys relatively low costs per head. The components of this system are similar to the confined system previously mentioned with the exception that animals are confined to a lot only during milking. Thus, the fixed costs and variable costs are similar, but nutrient returns are reduced substantially. Annual net system costs per animal are $15.78 for 200 head and $12.66 for 500 head (Table 9).

Unpaved Lot with Shade--

This system is designed primarily for warm and hot arid regions and has

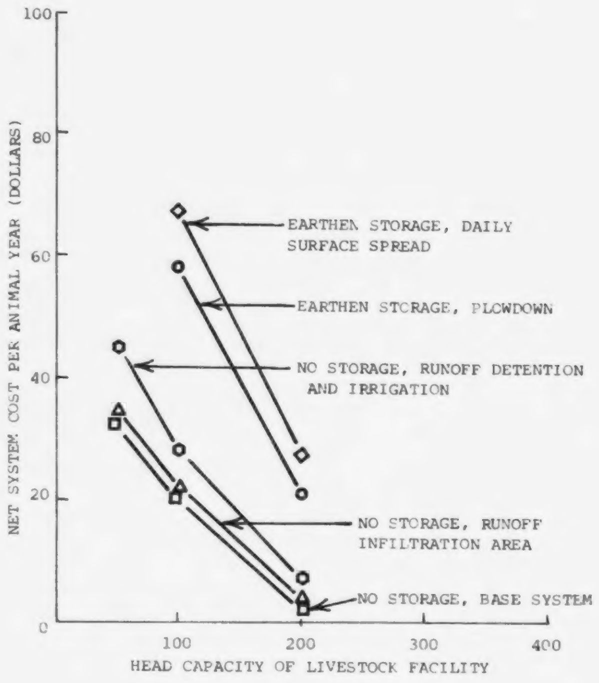

Figure 21. Dairy, annual net system cost for free stall, open lot, tractor scrape (100% utilization of available nutrients assumed).

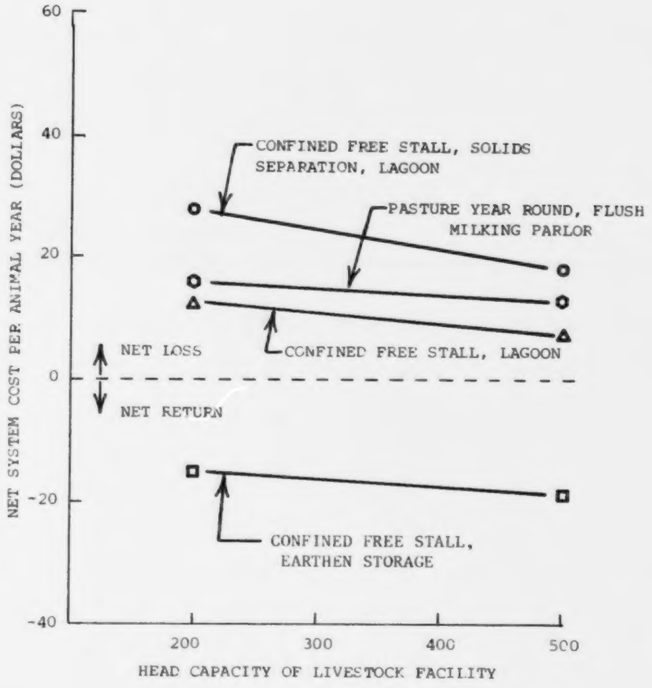

Figure 22. Dairy, annual net system costs for flush systems (100% utilization of available nutrients assumed).

TABLE 9 . DAIRY, FLUSH SYSTEMS, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients: 50 Percent Usage of Available Nutrients (4)	Returns to Nutrients: 100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	Net System Returns: At 50 Percent Usage of Nutrients (4)-(6)-(7)	Net System Returns: At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Free stall, lagoon, wastewater irrigate	Base	200	11.34	22.68	4.74	30.45	-23.86	-12.52	A-48
		500	11.34	22.68	3.19	26.78	-18.63	- 7.29	A-49
Free stall, earthen storage, wastewater irrigate	Base	200	23.57	47.14	6.69	25.45	- 8.57	+15.00	A-50
		500	23.57	47.14	6.37	21.76	- 4.57	+19.00	A-51
Free stall, solid separation, lagoon wastewater irrigate	Base	200	9.14	18.28	4.83	41.49	-37.18	-28.04	A-52
		500	9.14	18.28	4.15	32.44	-27.45	-18.31	A-53
Pasture year around, flush milking center, wastewater irrigate	Base	200	1.62	3.24	2.01	17.01	-17.40	-15.78	A-54
		500	1.62	3.24	2.01	13.88	-14.28	-12.66	A-55

[a] These systems are located primarily in hot humid, warm humid and warm arid regions.

TABLE 10. DAIRY, UNPAVED LOT WITH SHADE, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients		Variable Costs (6)	Fixed Costs (7)	Net System Returns		Appendix Reference
			50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)			At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	
					(Dollars per Animal Year)				
Tractor scrape, semi-annual spreading	Base	300	19.52	39.04	17.13	24.04	-21.65	- 2.13	A-56
	Runoff control detention/ irrigation	300	19.52	39.04	21.59	36.26	-38.33	-18.81	A-57
	Base	500	19.52	39.04	17.11	17.46	-15.05	+ 4.47	A-58
	Runoff control detention/ irrigation	500	19.52	39.04	23.00	26.80	-30.28	-10.76	A-59

[a] These systems are located primarily in warm arid, hot arid, and hot humid regions.

TABLE 11. DAIRY, CONFINED FREE STALL, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE MANAGEMENT SYSTEMS USING TRACTOR SCRAPING OR SLOTTED FLOORS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return: At 50 Percent Usage of Nutrients	Net System Return: At 100 Percent Usage of Nutrients	Level of Pollution[a]: Water: Quantity of Runoff	Level of Pollution[a]: Water: Quality of Runoff	Level of Pollution[a]: Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Tractor scrape, daily spread	Surface spread	50	-74.56	-50.35	2	2	1
	Surface spread	100	-55.24	-31.04	2	2	1
	Surface spread	200	-45.14	-20.93	2	2	1
Tractor scrape, plank storage (6 month)	Surface spread	50	-89.27	-63.54	2	2	2
	Surface spread	100	-63.82	-38.09	2	2	2
	Surface spread	200	-51.12	-25.39	2	2	2
Tractor scrape, pit storage (6 month)	Surface spread	50	-119.02	-95.45	2	2	4
	Plowdown	50	-115.57	-88.55	1	1	1
	Surface spread	100	-96.57	-73.00	2	2	4
	Plowdown	100	-93.12	-66.10	1	1	1
	Surface spread	200	-67.13	-43.56	2	2	4
	Plowdown	200	-63.68	-36.66	1	1	1
Slotted floor, pit storage (6 month)	Surface spread	100	-102.83	-79.26	2	2	4
	Plowdown	100	-99.38	-72.36	1	1	1

[a]Scale: 1 No Pollution, 2, 3, 4, 5 Severe Pollution

TABLE 12. DAIRY, CONFINED FREE STALL, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE MANAGEMENT SYSTEMS USING MECHANICAL SCRAPING

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return: At 50 Percent Usage of Nutrients	Net System Return: At 100 Percent Usage of Nutrients	Level of Pollution[a]: Water: Quantity of Runoff	Level of Pollution[a]: Water: Quality of Runoff	Level of Pollution[a]: Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Mechanical scrape, piston pump, earthen storage	Surface spread	50	-142.63	-119.06	2	2	4
	Plowdown	50	-139.17	-112.15	1	1	1
	Surface spread	100	- 85.99	- 62.42	2	2	4
	Plowdown	100	- 82.54	- 55.52	1	1	1
	Surface spread	200	- 59.77	- 36.20	2	2	4
	Plowdown	200	- 56.19	- 29.17	1	1	1
Mechanical scrape, piston pump, silo storage (3 month)	Surface spread	100	- 88.25	- 64.68	2	2	4
	Plowdown	100	- 84.80	- 57.78	1	1	1
Mechanical scrape, pit storage (6 month)	Surface spread	100	-133.05	-104.48	2	2	4
	Plowdown	100	-129.60	-102.58	1	1	1

[a] Scale; 1 No Pollution, 2, 3, 4, 5 Severe Pollution

TABLE 13. DAIRY, CONFINEMENT STALL, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Water		
					Quantity of Runoff	Quality of Runoff	Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Gutter cleaner, daily spread	Surface spread	50	-63.44	-39.23	2	2	1
	Surface spread	100	-57.66	-33.45	2	2	1
Gutter cleaner, piston pump, concrete storage (6 month)	Surface spread	50	-92.56	-66.35	2	2	2
	Plowdown	50	-90.16	-61.55	1	1	1
	Surface spread	100	-69.66	-43.45	2	2	2
	Plowdown	100	-67.26	-38.65	1	1	1
Gutter cleaner, stacker, plank storage (6 month)	Surface spread	50	-88.40	-62.67	2	2	2
	Plowdown	50	-86.24	-58.35	1	1	1
	Surface spread	100	-73.39	-47.66	2	2	2
	Plowdown	100	-71.23	-43.34	1	1	1

[a] Scale: 1 No Pollution, 2, 3, 4, 5 Severe Pollution

TABLE 14. DAIRY, FREE STALL OPEN LOT, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE MANAGEMENT SYSTEMS WITHOUT STORAGE

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
			At 50 Percent Usage of Nutrients	At 100 Percnet Usage of Nutrients	Water		Odor
					Quantity of Runoff	Quality of Runoff	
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Tractor scrape, daily spread, surface spread	Base	50	-56.62	-32.41	3	3	2
	Runoff control-infiltration	50	-58.69	-34.48	2	2	2
	Runoff control-detention	50	-70.17	-45.96	1	1	2
	Base	100	-44.21	-20.00	3	3	2
	Runoff control-infiltration	100	-45.82	-21.61	2	2	2
	Runoff control-detention	100	-52.45	-28.24	1	1	2
	Base	200	-24.87	- 0.66	3	3	2
	Runoff control-infiltration	200	-26.88	- 2.67	2	2	2
	Runoff control-detention	200	-30.97	- 6.76	1	1	2

[a] Scale: 1 2 3 4 5
No Pollution — Severe Pollution

substantial economies of size. For the basic system annual net system costs are $2.13 per head for the 300 head facility (Table 10). With the basic system the 500 head lot enjoys annual net system returns of $4.47 per head since nutrient returns outweigh system costs. The pollution control is a detention basin/irrigation system and net annual system costs and returns are increased to $18.81 and $10.76 per head for 300 and 500 head, respectively.

LEVEL OF AIR AND WATER POLLUTION FROM DAIRY SYSTEMS

The typical systems used in this analysis have relatively little problem with pollution control. Dairy animal numbers concentrated on a farm are generally small; thus, severe problems of odor and runoff control are less than those for some other species.

Water pollution level estimates are rated as 1 (no pollution) or 2 (slight pollution) for all confined free stall and confinement stall systems (Tables 11, 12, and 13). These levels indicate that water pollution problems are generally minimal. However, runoff problems may result when spreading occurs without plowdown or soil injection. Thus, for those systems using daily spreading, a water quality and quantity parameter of 2 is assigned (Table 11). In addition, odor problems may result when spreading occurs without plowdown.

For free stall open lot systems, water pollution problems become more prevalent. This basic system allows some runoff from exposed lot surfaces; thus, water pollution is rated at 3 (moderate pollution) in Table 14. Using the diversion terrace, settling basin, grass infiltration components reduces water pollution to a rating of 2 (Table 14). Water quality can be improved significantly with the diversion terrace, settling basin, detention basin, irrigation system.

Free stall open lot systems using earthen storage have some capacity to prevent runoff from leaving the farm and entering water courses. This system provides adequate water pollution control with a rating of 2 (Table 15). It also allows significant reduction in odor when plowdown of manure is used rather than surface spreading.

Runoff control and odor are controlled well on properly managed flush systems (Table 16). Even though large numbers of animals are concentrated in these systems, pollution control is adequate.

Runoff problems may be significant on unpaved lots, as seen in Table 17, where the base system has water pollution levels of 5 (severe pollution). With large quantities of manure stored on exposed lot surfaces, an intense rainfall may create serious water quality problems. Most lots use a detention/irrigation system to control runoff (Table 17).

TRADEOFFS BETWEEN SYSTEM COSTS AND POLLUTION CONTROL

The difference between net annual costs of pollution control systems and the resulting change in water and air quality are shown in Tables 11 through 17.

TABLE 15. DAIRY, FREE STALL OPEN LOT, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE MANAGEMENT SYSTEMS WITH STORAGE

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Water		Odor
					Quantity of Runoff	Quality of Runoff	
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Tractor scrape, piston pump, earthen storage	Surface spread	100	-91.20	-67.63	2	2	4
	Plowdown	100	-87.74	-60.72	1	1	1
	Surface spread	200	-50.96	-27.39	2	2	4
	Plowdown	200	-47.51	-20.49	1	1	1

[a] Scale: 1 2 3 4 5
No Pollution Severe Pollution

TABLE 16. DAIRY, FLUSH SYSTEMS, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
					Water		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Quantity of Runoff	Quality of Runoff	Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Confined free stall, lagoon, wastewater irrigation	Base	200	-23.86	-12.52	2	2	2
		500	-18.63	- 7.29	2	2	2
Confined free stall, earthen storage, waste water irrigate	Base	200	- 8.57	+15.00	2	2	2
		500	- 4.57	+19.00	2	2	2
Confined free stall, solid separation, lagoon, waste-water irrigate	Base	200	-37.18	-28.04	2	2	2
		500	-37.18	-28.04	2	2	2
Pasture year around, flush milking center, wastewater irrigate	Base	200	-17.40	-15.78	2	2	1
		500	-14.28	-12.66	2	2	1

[a] Scale: 1 No Pollution, 2, 3, 4, 5 Severe Pollution

TABLE 17. DAIRY, UNPAVED LOT WITH SHADE, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return: At 50 Percent Usage of Nutrients	Net System Return: At 100 Percent Usage of Nutrients	Level of Pollution[a]: Water: Quantity of Runoff	Level of Pollution[a]: Water: Quality of Runoff	Level of Pollution[a]: Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Tractor scrape, semi-annual spreading	Base	300	-21.65	- 2.13	5	5	3
	Runoff control-detention/ irrigation	300	-38.33	-18.81	2	2	3
	Base	500	-15.05	+ 4.47	5	5	3
	Runoff control-detention/ irrigation	500	-30.28	-10.76	2	2	3

[a] Scale: 1 No Pollution, 2, 3, 4, 5 Severe Pollution

For the free stall open lot systems (Table 14), runoff control may be expensive relative to the improved water and air quality. Imposing a grass infiltration area increases net system costs by $2.07 per head ($34.48 - $32.41) for the 50 cow herd and $1.61 per head ($21.61 - $20.00) for the 100 cow herd. Imposing a detention/irrigation system increases net costs by $13.55 per head for the 50 cow herd, and $8.24 per head for the 100 cow herd.

For the free stall open lot system with earthen storage (Table 15), soil incorporation not only improves water and air quality, but it also improves returns due to improvements in nutrient availability. For the 200 head capacity facility, per head annual net costs are reduced by $6.90 while water quality is improved slightly and odor control is improved substantially at the time of spreading.

Other systems using soil incorporation exhibit similar benefits. For example, the confinement stall system with storage (Table 13) has reduced annual net system costs of about $4 to $5 per head when waste is incorporated in the soil, and all of the pollution parameters improve slightly. Confined free stall systems with storage and plowdown (Tables 11 and 12) also exhibit similar qualities.

The implication that soil incorporation is to be prescribed for all systems is erroneous. It is only a feasible alternative where storage is already part of the system. To require herds now using daily spreading to use soil incorporation would require the expensive addition of storage.

For herds in the Southwest using unpaved lots, constructing a detention basin/irrigation system is both an expensive and an effective means of controlling runoff. Annual net system costs are increased by approximately $16 per head while water quality parameters are improved substantially as seen in Table 17.

SECTION 7

BEEF WASTE MANAGEMENT OPTIONS

WASTE SYSTEMS

Beef production units are mainly cow-calf operations or fed beef operations. Stockers, or beef fed on grass from 450 to 750 pounds, is a third group in some areas of the country. In recent years the profit margin for beef production has been very small and at a number of points there have been losses. Therefore, beef producers look for economical methods and equipment for handling the manure.

In the 18 major beef producing states, 181,000 or 99% of the fed beef operations are less than 1000 head capacity. These fed beef operations produce about 51% of the total beef marketings in these states (Johnson, et al, 1975). It is estimated that 49,000 fed beef facilities or about 27% of all operations had pollution runoff problems. Three-fourths of the operations with problems had less than 100 head capacity (Johnson, et al, 1975).

Climate is the principal factor in selecting feedlot site location, type of shelter, and type of waste system. A major beef feeding area is in the Great Plains area which typically has an annual moisture deficiency (rainfall minus evapotranspiration) of approximately 30 inches of water. In the cold areas of this region, shelter is usually provided with the open feedlots; in the cool and warm arid region, no shelter is provided. In the cold humid, cool humid and warm humid regions, shelter is usually provided for the winter months. In the hot humid, hot arid and warm arid regions, shade becomes important in the summer months.

The most common type of fed beef lot is that shown in Figure 23. This unpaved lot without shelter is typically 400 sq. ft. per head. Manure is scraped from the lot once or twice a year. If the feedlot cannot be located on sloping ground (3 to 6% slope recommended), then a mound of soil and manure is usually provided, as shown in Figure 23. The detention basin-irrigation system or the grass infiltration system is an option to control rainfall runoff.

A paved feedlot with shelter is shown in Figure 24. A manure pack is allowed to accumulate in the shelter and is scraped and loaded into a box spreader between groups of cattle. The paved surface should be scraped regularly and the manure either stored or field spread directly. A plank walled storage is shown in the insert. Normally, 25 sq. ft. of floor in the shelter and 30 sq. ft. of paved lot is provided per animal. Also, an unpaved feedlot may have shelter similar to that shown in Figure 24. In the case of an unpaved lot with shelter, the lot area is typically 150 sq. ft. per animal

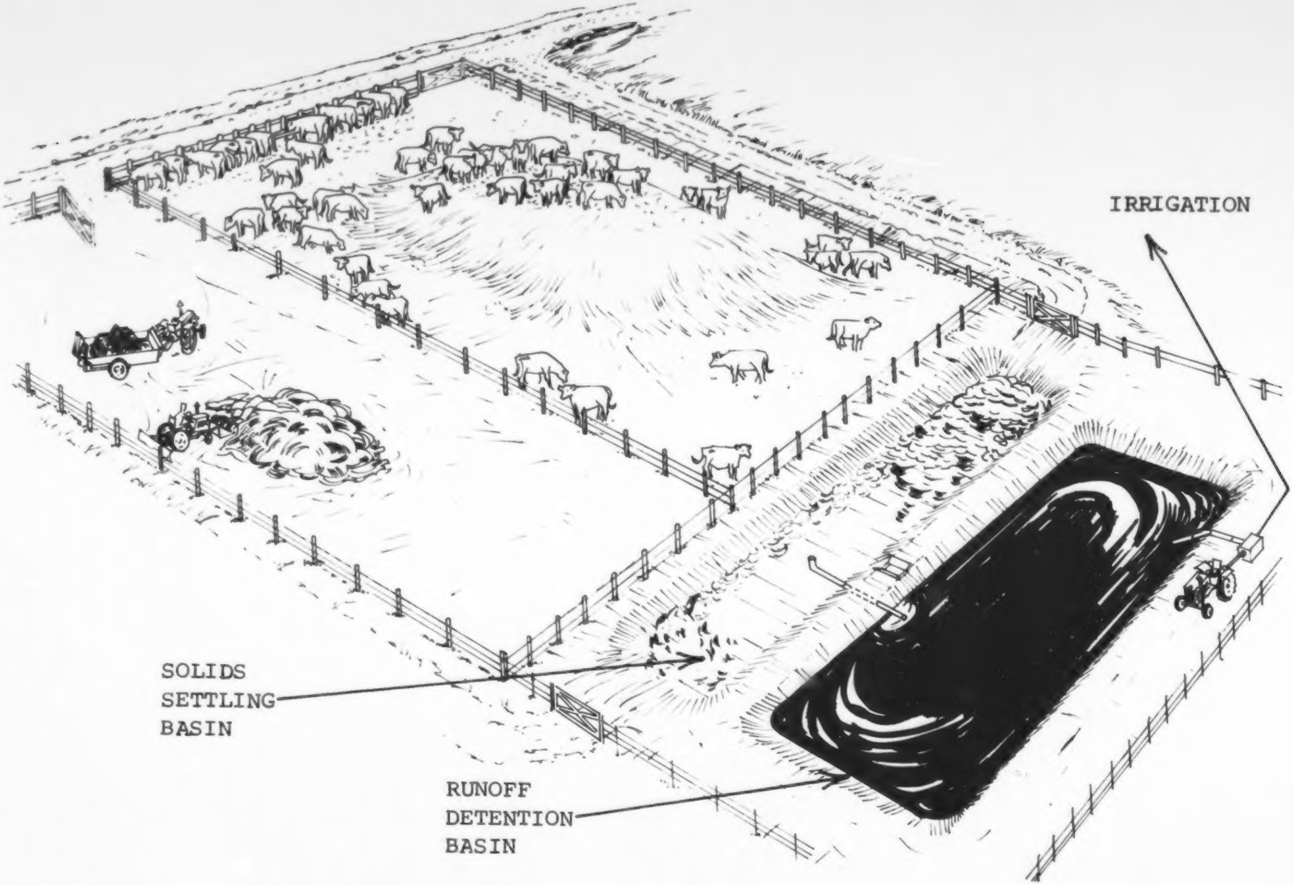
IRRIGATION
SOLIDS SETTLING BASIN
RUNOFF DETENTION BASIN

Figure 23. Fed beef dry lot. Manure is scraped from lot periodically and spread on cropland. Runoff settling and detention basins are shown.

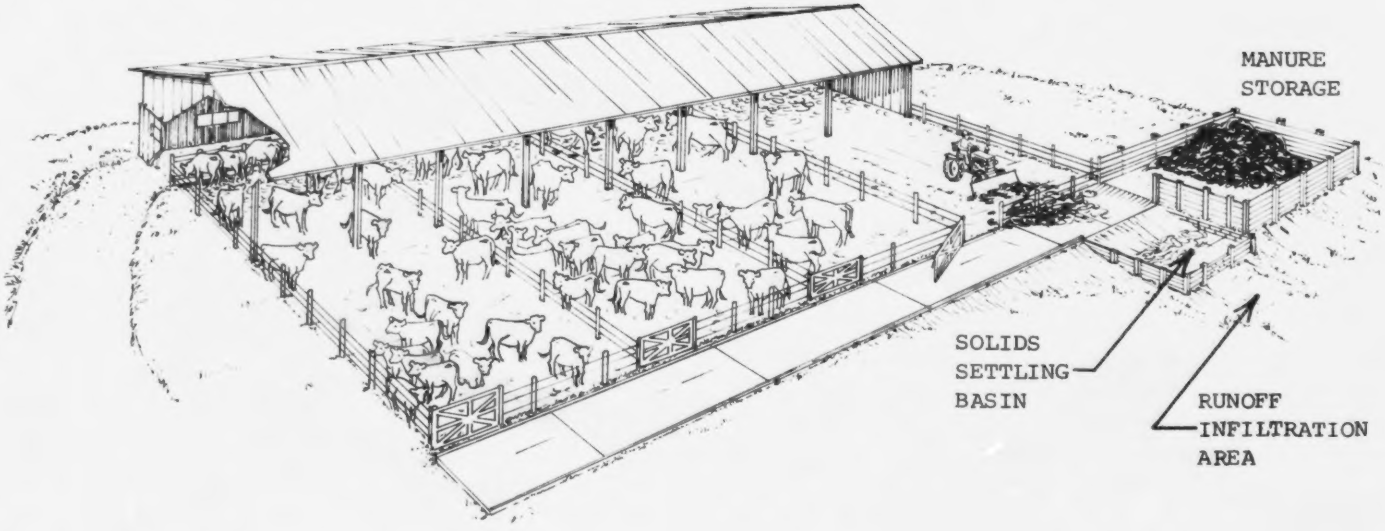
MANURE
STORAGE
SOLIDS
SETTLING
BASIN
RUNOFF
INFILTRATION
AREA

Figure 24. Paved beef feed lot typical of cold and cool humid areas.

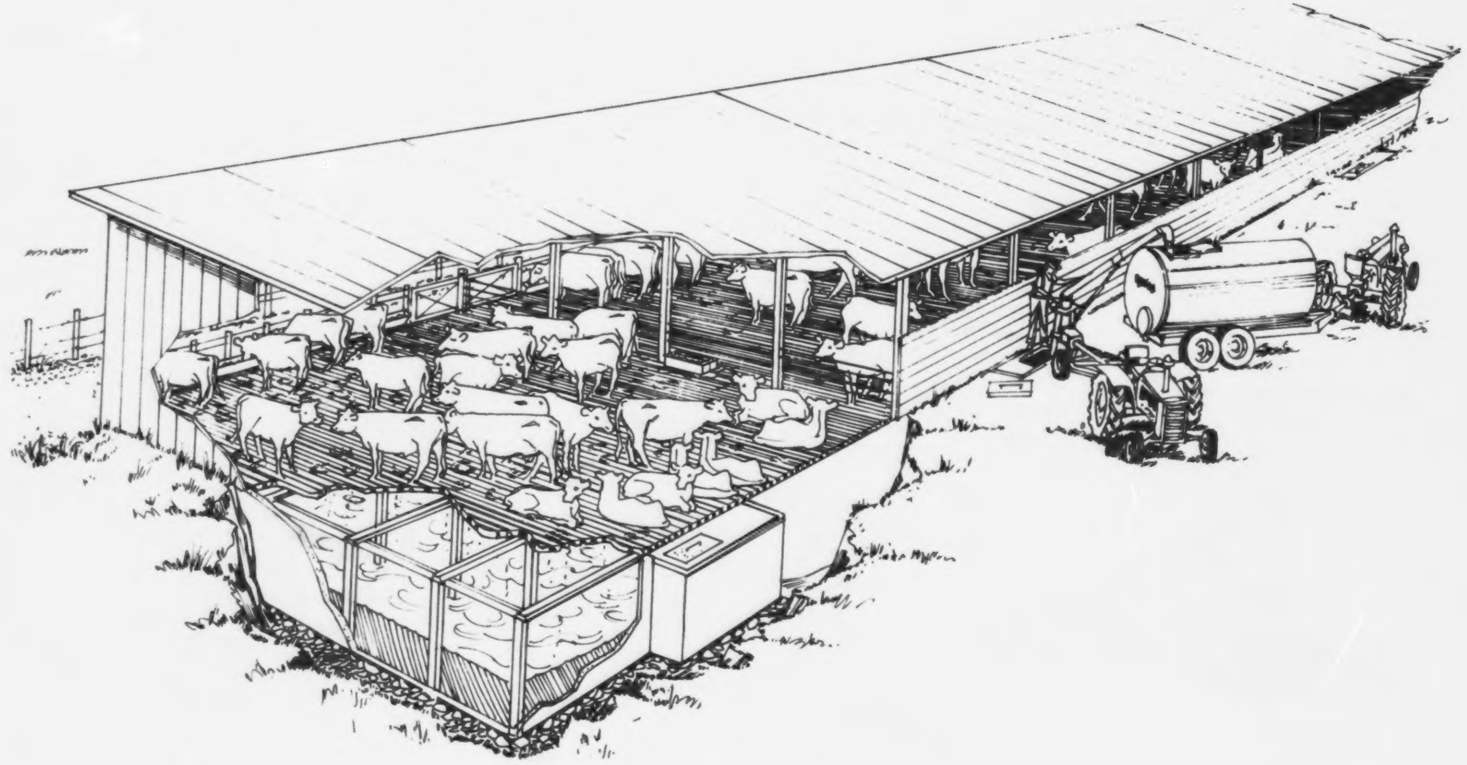

Figure 25. Total confinement, slotted floor, pit storage, liquid manure handling system.

with another 30 sq. ft. under roof. In these systems feeding may be done under the roof or in a fenceline feed bunk as shown.

In cooler and humid regions, some beef feeding operators prefer total confinement under shelter. A common system is the slotted floor with pit storage (Figure 25). A minimum of 90 days storage is usually recommended. The principal problem with this system is odor nuisance. Soil incorporation of the liquid slurry when spreading is the recommended management practice to control odors. Soil incorporation may be done by injecting or immediate plowdown. Soil incorporation also has an added benefit of conserving more nitrogen for crop use.

Some operators who wish to automate their beef manure handling systems use flushing. This system is suitable where feezing does not occur for extended periods in the winter. It is used in the warm humid and hot humid regions for some fed-beef operations.

Most beef cow-calf operations utilize a pasture (range) feeding regime. In the cool and cold portions of the United States, feedlots for wintering beef cows are used. Unpaved and paved feedlots with shelter are commonly used, similar to that shown for fed-beef in Figure 24. In the warm and hot areas, cows are usually wintered on the pasture and forage brought to them as needed.

A pasturing system commonly used for stocker cattle in the Southern Plains region is winter pasturing on fall planted wheat. Care must be taken not to overstock the wheat field. No waste management system is needed for this type of operation.

OPTIONS TO BE ANALYZED

Fed beef: The size of beef feedlots has trended upward in recent years although low prices in the mid-1970's has slowed this trend. It is expected that production and marketing efficiencies will continue to provide incentives to concentrate large numbers of feeders in large western lots. However, Corn Belt feedlots will remain a major source of fed beef. These lots are much smaller than their western counterparts and are primarily the focus on this section. While relatively few efforts have been made to control pollution from these smaller lots, large lots have been the focus of the National Pollutant Discharge Elimination System (NPDES). All of the following systems assume 100, 400, and 700 head capacity feedlots. Each type is assumed to have a turnover rate of 1.2, producing marketings of 120, 480, and 840 head per year.

Fed beef waste systems analyzed are:

Fed beef, unpaved lot, shelter, solid handling

1. Base system
2. Base system with diversion, settling basin and grass infiltration area
3. Base system with diversion, settling basin, lagoon, and wastewater irrigation

Fed beef, paved lot, shelter, solid handling

1. Base system
2. Base system with diversion, settling basin, and grass infiltration area
3. Base system with diversion, settling basin, lagoon, and wastewater irrigation

Fed beef, unpaved lot, no shelter, solid handling

1. Base system
2. Base system with diversion, settling basin, and grass infiltration area
3. Base system with diversion, settling basin, lagoon, and wastewater irrigation

Fed beef, confined, slotted floor, pit storage, liquid handling

1. Base system
2. Base system with soil incorporation of manure by injection

Control of rainfall runoff is the major pollution control unit needed on units with exposed lot surfaces. Runoff control may be either the detention basin-irrigation system or the settling basin-grass infiltration system. On confined lots with manure storage, soil incorporation is the major pollution control option to prevent runoff of spread manure from cropland.

Stockers: The midwestern states often include the grazing of beef stockers (400-700 lbs.) on wheat stubble or grass. Animal density is low, and no waste disposal system is required. No waste disposal estimates have been provided for this feeding regime since no costs are incurred and net benefits from manure nutrients are minimal.

Pollution control is related to grazing management practices which prevent overstocking of pasture. Overstocking reduces the vegetation covering the soil and permits increased runoff. Suggested stocking rates vary by location and time of the year, and producers should consult local Cooperative Extension Service personnel to find appropriate stocking rates.

Cow-calf enterprises are found on land that is not readily suitable for more profitable feed, food, and fiber crops. Generally, the alternatives for this land are limited and extensive pasturing is a reasonable land use practice. As with beef stockers, the cow-calf enterprise on a pasture system does not require a waste disposal system. However, during the winter months the breeding cows are normally restricted to a lot and may be provided shelter. The cows are usually returned to pasture (range) for calving.

Two systems for beef cow-calf waste facilities during winter confinement are analyzed:

1. Pasture, unpaved lot with shelter, tractor scraper/loader, solid handling
2. Pasture, paved lot with shelter, tractor scraper/loader, solid handling

Pollution control options are the detention basin-irrigation system and the settling basin-grassed infiltration system. Smaller quantities of runoff will occur from the smaller paved lot but the concentration of pollutants may be larger.

ECONOMIC ANALYSIS

The organization of the economic analysis of beef waste management systems is to estimate farmers' returns and costs for alternative systems first. Then qualitative estimates of society costs in terms of water and air quality are made. Finally, the trade offs between the costs of pollution control and the benefits of improved water and air quality are depicted.

Benefits from Waste

Economic benefits accruing to waste are dependent on the quantities of nutrients in the waste and the losses in storing, handling and spreading. Generally, substantial nitrogen losses occur on beef feedlots or cow-calf wintering facilities. A manure pack on the lot surface or storage in mounds allows nitrogen losses of over 50 percent for most situations (Table 18).

Once the losses due to storing, handling, and spreading have been computed (as in Table 18), assumptions need to be made about crop utilization of available nutrients. For fed beef, two sets of nutrient utilization assumptions are used. First, it is assumed that 100 percent of available nutrients is utilized. The second set assumes that 50 percent of available nutrients is utilized.

For the cow-calf enterprise, part of the manure is from the lot and can be allocated to cropland. However, part is returned to pasture or range land by the pasturing cow. For both the manure from the lot and manure from the pasture, the 100 percent and 50 percent utilization assumptions are used.

As with dairy systems, nutrients are priced at $0.16 per pound for nitrogen, $0.18 for phosphate ($P_2O_5$), and $0.10 for potash ($K_2O$). These prices are multiplied by the assumed amount of utilized nutrients to arrive at the nutrient return.

Analysis of Options

Due to the relative simplicity of most beef waste systems, waste disposal generally returns a profit (Table 19). Waste system components are few and the capital investment and labor utilization are small compared to the more elaborate dairy systems.

It does not follow that positive net returns for beef systems having effective pollution control will be accepted by farmers. Although a system may have positive annual returns, they may be quite expensive compared to other less elaborate systems where returns are even higher for waste disposal.

TABLE 18. NITROGEN, PHOSPHATE (P_2O_5), AND POTASH (K_2O) AVAILABLE TO CROPS FROM BEEF WASTE, PER ANIMAL UNIT[a] FOR ALTERNATIVE HANDLING SYSTEMS

System	Lbs/Year Available to Crops/Animal Unit[b]		
	Nitrogen	Phosphate (P_2O_5)	Potash (K_2O)
Feeders (1000 lb)			
Unpaved lot, shelter, solid handling	53	64	80
Paved lot, shelter, solid handling	58	64	80
Unpaved lot, no shelter, solid handling	45	46	64
Total shelter, slotted floor, liquid handling	68	82	95
Total shelter, slotted floor, liquid handling, injection	88	86	101
Paved lot, shelter, flushing, lagoon, irrigation	19	46	64
Stockers (500 lbs)			
Pastured on winter wheat	23	22	26
Cow-Calf (1250 lbs)			
Pasture year around	98	100	114
Pasture, winter in unpaved lot, solid handling	77	85	100
Pasture, winter in paved lot, shelter, solid handling	80	85	100

[a] One animal unit: feeder at 1000 lbs, 2 stockers at 500 lbs, cow-calf at 1250 lbs

[b] Production of nutrients per year:

	N (lbs)	P_2O_5 (lbs)	K_2O (lbs)
1000 lb feeder animal	124	91	106
500 lb stocker	62	45	53
1250 lb cow-calf	131	100	114

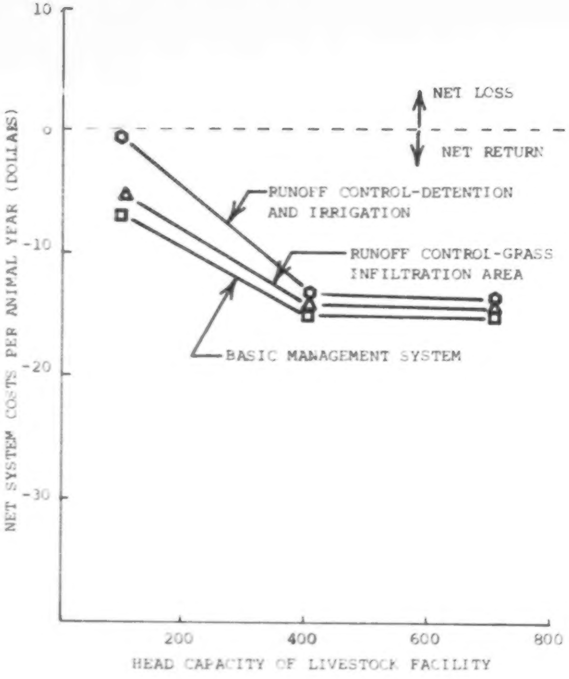

Figure 26. Fed beef, annual net systems costs for paved dry lot (100% utilization of available nutrients assumed).

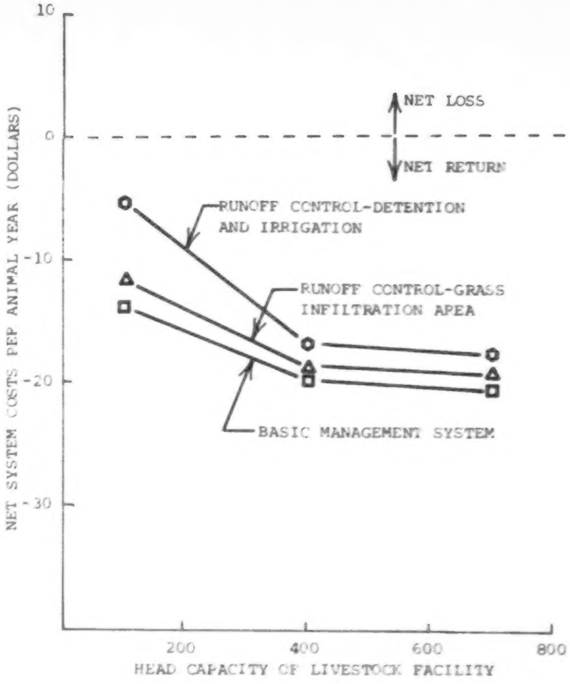

Figure 27. Fed beef, annual net system costs for unpaved dry lot, (100% utilization of available nutrients assumed).

Fed Beef, Dry Lot, Paved--

The dry lot, paved system has two pollution control options, the grass infiltration or the detention/irrigation system. Annual net system costs for the basic system and the two pollution control options are illustrated in Figure 26. For the basic system with no pollution control, annual net system returns range from $6.93 per head for the 100 head lot to $15.47 per head for the 700 head lot (Table 19).

Adding grass infiltration pollution control components increases annual net system costs $1.70 per head for the 100 head lot ($6.93 - $5.23, Table 19) and $0.74 per head for the 700 head lot ($15.47 - $14.73, Table 19). Thus, pollution control costs for the grass infiltration area are minimal.

Adding the detention basin/irrigation system as a pollution control option increases costs more than does the grass infiltration system. With the detention/irrigation system, annual net system costs are increased $6.23 per head for the 100 head lot ($6.93 - $0.70, Table 19) and $1.49 per head for the 700 head lot ($15.47 - $13.96, Table 19).

Annual net system returns in Table 19 are depicted graphically in Figure 26. It is apparent that economies of size are gained at about 400 head where costs reach low levels. Also, it is apparent that the detention/irrigation method of controlling runoff is substantially more expensive than the grass infiltration method for the smaller lot sizes.

Fed Beef, Dry Lot, Unpaved--

Net system costs for the dry lot, unpaved system are shown in Table 20. Due to the smaller labor requirements and slightly lower capital requirements, the annual net system returns are generally higher than that from the dry lot, paved system. Net annual returns for the basic dry lot, unpaved system range from $13.75 per head for the 100 head capacity lot to $20.28 per head for the 700 head lot.

Pollution control technology in the form of the grass infiltration option increases costs $2.24 per head on the 100 head lot ($13.75 - $11.51, Table 20) and $1.34 per head on the 700 head lot ($20.28 - $18.94, Table 20). If the detention/irrigation system is added, costs increase $8.33 per head on the 100 head lot and $2.66 per head on the 700 head lot.

Runoff control is more expensive on the unpaved lot than the paved lot, fed beef systems. Larger capital investments are needed for diversion, settling basin, detention basin, and wastewater irrigation components. For example, on the 100 head paved lot, adding the detention/irrigation runoff control system costs $6.23 per head (Table 19). However, on the 100 head unpaved lot, it costs $8.33 per head.

Again, most economies of size are gained with 400 head capacity on the dry lot, unpaved feedlot (Figure 27). Thus, smaller producers bear substantially higher per-unit costs than do the larger producers.

Fed Beef, Total Shelter--

The total shelter, fully slotted floor, pit storage technology reduces

TABLE 19. FED BEEF, ANNUAL COSTS AND RETURNS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS WITH DRY LOT PAVED SYSTEMS[a]

			Returns to Nutrients				Net System Returns		
Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Dry lot, partial shelter, paved, solid spread	Base	100	14.40	28.80	4.93	16.94	- 7.47	6.93	B-1
	Runoff control-detention/irrigation	100	14.40	28.80	5.48	22.62	-13.70	0.70	B-2
	Runoff control-grass infiltration	100	14.40	28.80	5.48	18.08	- 9.17	5.23	B-3
	Base	400	14.40	28.80	4.32	9.29	0.78	15.18	B-4
	Runoff control-detention/irrigation	400	14.40	28.80	4.51	11.06	- 1.17	13.23	B-5
	Runoff control-grass infiltration	400	14.40	28.80	4.51	9.90	- 0.11	14.29	B-6
	Base	700	14.40	28.80	4.85	8.48	1.07	15.47	B-7
	Runoff control-detention/irrigation	700	14.40	28.80	5.08	9.75	- 0.44	13.96	B-8
	Runoff control-grass infiltration	700	14.40	28.80	5.08	8.98	0.33	14.73	B-9

[a] Regions: cold humid and cool humid.

TABLE 20. FED BEEF, ANNUAL COSTS AND RETURNS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS WITH DRY LOT UNPAVED SYSTEMS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients: 50 Percent Usage of Available Nutrients (4)	Returns to Nutrients: 100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	Net System Returns: At 50 Percent Usage of Nutrients (4)-(6)-(7)	Net System Returns: At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Dry lot, partial shelter, unpaved, solid spread	Base	100	14.00	28.00	3.14	11.12	-0.25	13.75	B-10
	Runoff control with detention/ irrigation	100	14.00	28.00	3.87	18.71	-8.58	5.42	B-11
	Runoff control-grass infiltration	100	14.00	28.00	3.67	12.61	-2.49	11.51	B-12
	Base	400	14.00	28.00	2.53	5.85	5.62	19.62	B-13
	Runoff control-detention/ irrigation	400	14.00	28.00	3.12	8.03	2.85	16.85	B-14
	Runoff control-grass infiltration	400	14.00	28.00	3.12	6.26	4.62	18.53	B-15
	Base	700	14.00	28.00	2.57	5.15	6.28	20.28	B-16
	Runoff control-detention/ irrigation	700	14.00	28.00	3.53	6.85	3.62	17.62	B-17
	Runoff control-grass infiltration	700	14.00	28.00	3.53	5.53	4.94	18.94	B-18

[a] Regions: cool humid, cold humid, cool arid, cold arid.

labor requirements but significantly increases capital investments. As a result, waste management costs per head are greater for this system than for any of the others. Net annual system returns for the basic system are shown in Table 21, and they range from -$14.72 per head for the 100 head lot to $2.94 for the 700 head lot.

Adding soil incorporation to the waste spreading operation increases fixed and variable costs slightly, but it produces even larger returns from nutrients. With incorporation, annual net system returns are improved by $0.16 per head for the 100 head lot ($14.56 - $14.72, Table 21) and $3.09 per head for the 700 head lot ($6.03 - $2.94, Table 21).

Incorporation of stored animal waste is a system modification which improves returns as seen in Figure 28. Furthermore, the larger the feedlot, the larger the per-head savings, as fixed costs are spread over more units of output. Again, lot sizes of approximately 400 head realize most of the economies of size for waste management on the total shelter, fully slotted floor system.

Fed Beef, Unpaved Lot, No Shelter--

While this system is limited to areas with cool arid, warm arid, and hot arid climates, the waste disposal costs compare favorably with other systems. Annual net system returns are $5.52 for the 100 head lot and $13.83 for the 700 head lot (Table 22). For areas where this system is adaptable, detention basin/irrigation systems would be the likely pollution control technology. This technology lowers annual net system returns by $7.81 per head for the smaller lot and $2.74 per head for the larger lot (Table 22).

As with other systems, the runoff control system using detention/irrigation adds substantial fixed costs to fed beef. For the 400 head unpaved lot without shelter, adding the detention/irrigation components lowers waste management returns by $3.17 per head ($15.13 - $11.95, Table 22). Of this $3.17 per-head cost, variable costs account for only $0.38 per head while fixed costs account for $2.79 per head.

Cow-Calf, Pasture, Paved Lot and Unpaved Lot--

Both the basic paved lot and unpaved lot systems incur similar costs and returns (Figure 29). The components of these systems are much the same, with the difference consisting of the structure for wintering. Of course, runoff control requirements change between the lots due to the different lot structures.

For both basic systems, annual net system returns varying between approximately $13 per head for the 40 cow herd to $30-$31 per head for the 200 cow herd (Tables 23 and 24).

Runoff control with detention/irrigation is relatively expensive on the unpaved lot as components are sized larger to accommodate the larger lot area. For the unpaved lot using grass infiltration, annual net system costs are $1.22 per head for the 40 cow lot ($13.23 - $12.01, Table 24), and $1.09 per head for the 200 cow lot ($30.35 - $29.16, Table 24). For the unpaved

TABLE 21. FED BEEF, ANNUAL COSTS AND RETURNS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS WITH FULLY SLOTTED SYSTEMS[a]

			Returns to Nutrients				Net System Returns		
Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
				(Dollars per Animal Year)					
Total shelter, fully sotted, liquid spread, 90-day storage	Base	100	17.57	35.14	10.14	39.72	-32.29	-14.72	B-19
	Injection	100	19.83	39.66	10.94	43.28	-34.39	-14.56	B-20
	Base	400	17.57	35.14	9.91	22.59	-14.93	2.64	B-21
	Injection	400	19.83	39.66	10.71	23.48	-14.36	5.47	B-22
	Base	700	17.57	35.14	11.40	20.80	-14.63	2.94	B-23
	Injection	700	19.83	39.66	12.33	21.30	-13.80	6.03	B-24

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[a] Regions: cool humid, cold humid

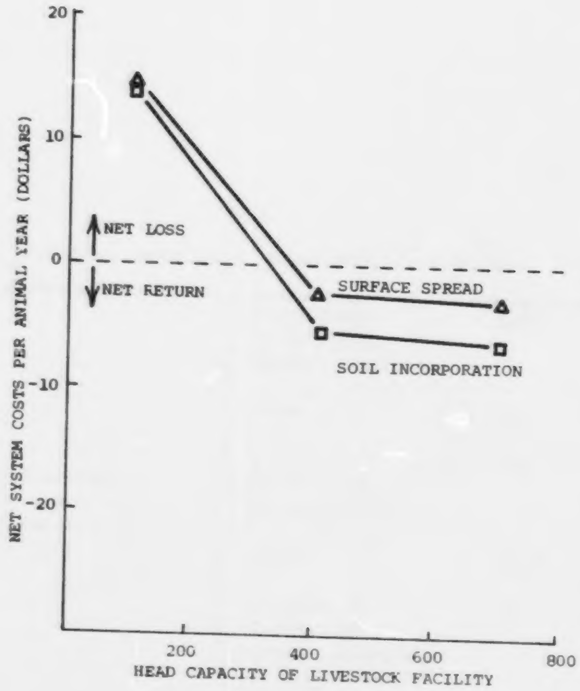

Figure 28. Fed beef, annual net system costs for total shelter, fully slotted floor (100% utilization of available nutrients assumed).

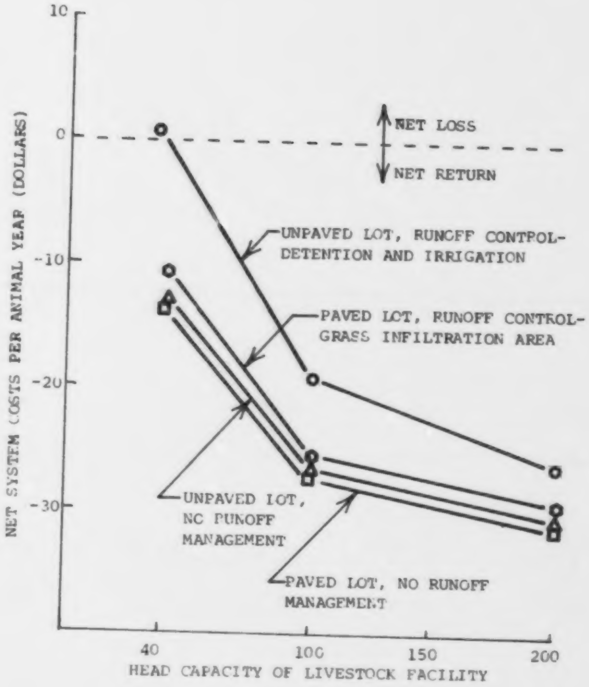

Figure 29. Beef cow/calf, annual net system costs for paved lot and unpaved lot (100% utilization of available nutrients assumed).

TABLE 22. FED BEEF, ANNUAL COSTS AND RETURNS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS WITHOUT SHELTER[a]

			Returns to Nutrients				Net System Returns		
Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
			(Dollars per Animal Year)						
Unpaved lot, no shelter, solid spread	Base	100	10.94	21.88	6.57	9.79	- 5.42	5.52	B-25
	Runoff control-detention/ irrigation	100	10.94	21.88	7.10	17.07	-13.23	- 2.29	B-26
	Base	400	10.94	21.88	2.64	4.11	4.19	15.13	B-27
	Runoff control-detention/ irrigation	400	10.94	21.88	3.03	6.91	1.00	11.94	B-28
	Base	700	10.94	21.88	4.69	3.36	2.89	13.83	B-29
	Runoff control-detention/ irrigation	700	10.94	21.88	5.17	5.62	0.14	11.08	B-30

[a] Regions: cool arid, warm arid, hot arid.

TABLE 23. BEEF COW-CALF, ANNUAL COSTS AND RETURNS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS WITH PASTURE, PAVED LOT[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients: 50 Percent Usage of Available Nutrients (4)	Returns to Nutrients: 100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	Net System Returns: At 50 Percent Usage of Nutrients (4)-(6)-(7)	Net System Returns: At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
			(Dollars per Animal Year)						
Pasture, paved lot, winter shelter, solid spreading	Base	40	19.05	38.10	2.69	21.86	- 5.50	13.55	B-31
	Runoff control-grass infiltration	40	19.05	38.10	3.11	24.83	- 8.89	10.16	B-32
	Base	100	19.05	38.10	2.11	8.81	8.13	27.18	B-33
	Runoff control-grass infiltration	100	19.05	38.10	2.36	10.07	6.62	25.67	B-34
	Base	200	19.05	38.10	1.86	38.10	11.97	31.02	B-35
	Runoff control-grass infiltration	200	19.05	38.10	2.15	6.27	10.63	29.68	B-36

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[a] Regions: cool humid, cold humid.

TABLE 24. BEEF COW-CALF, ANNUAL COSTS AND RETURNS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS WITH PASTURE, UNPAVED LOTS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients		Variable Costs (6)	Fixed Costs (7)	Net System Returns		Appendix Reference
			50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)			At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	
					(Dollars per Animal Year)				
Pasture, unpaved lot, winter shelter, solid spreading	Base	40	18.81	37.62	2.11	22.28	- 5.58	13.23	B-37
	Runoff control-Detention/irrigation	40	18.81	37.62	3.08	35.45	-19.72	-0.91	B-38
	Runoff control-grass infiltration	40	18.81	37.62	2.53	23.08	- 6.80	12.01	B-39
	Base	100	18.81	37.62	1.73	9.27	7.81	26.62	B-40
	Runoff control-detention/irrigation	100	18.81	37.62	2.44	16.02	0.36	19.17	B-41
	Runoff control-grass infiltration	100	18.81	37.62	1.99	10.05	6.77	25.58	B-42
	Base	200	18.81	37.62	1.51	5.75	11.54	30.35	B-43
	Runoff control-detention/irrigation	200	18.81	37.62	2.22	9.35	7.24	26.05	B-44
	Runoff control-grass infiltration	200	18.81	37.62	2.22	6.24	10.35	29.16	B-45

[a] Regions: cool arid, cold arid, cool humid, cold humid, warm humid.

lot using detention/irrigation, annual net system costs increase approximately $14 per head on the 40 cow lot and $4 per head on the 200 cow lot.

For the paved lot system, only the grass infiltration system is analyzed. Added annual costs with the grass infiltration components are $3.39 per head for the 40 cow lot ($13.55 - $10.16, Table 23) and $1.34 per head for the 200 cow lot ($31.02 - $29.68, Table 23).

LEVEL OF AIR AND WATER POLLUTION FROM BEEF SYSTEMS

The herd sizes for fed beef are generally larger than for dairy. These larger concentrations mean that uncontrolled pollution may cause more severe damages from beef feedlots than from dairy systems. The water pollution problems on fed beef dry lot, unpaved and paved basic systems are rated as severe (Tables 25 and 26).

Adapting the grass infiltration or the detention/irrigation system on dry lot paved or unpaved systems greatly abates potential pollution. The grass infiltration effectively controls water pollution but does not offer the complete elimination of runoff as does the detention/irrigation system. Slight water pollution (rating of 2, Tables 25 and 26) occurs with grass infiltration while no water pollution occurs with a properly designed detention/irrigation system. However, none of the systems effectively control the level of odor.

For the confinement, fully slotted system, water pollution is effectively controlled (Table 27). Any problems with runoff occur at the time of spreading, and soil injection provides a method of eliminating runoff of waste from the field. Injection also abates the odor nuisance that occurs when surface spreading.

Water pollution is rated as severe on the basic unpaved lot without shelter system (Table 28). Large areas of exposed lot surface which are scraped only occasionally provide the setting for severe runoff problems when prolonged and intense rains occur. Due to the location of these systems in moisture deficit areas, runoff control by the grass infiltration method is not recommended. Instead, detention/irrigation components are used and are able to reduce moderate runoff pollution to near zero levels. Odor nuisances are a characteristic of all unpaved lot systems.

As with all systems with exposed lot surfaces, the basic beef cow-calf systems present the problem of runoff from the lot area (Tables 29 and 30). However, concentrations are less, due to smaller herd sizes and pasturing during six months of the year. As with fed beef, the detention/irrigation and grass infiltration systems are effective pollution control methods for beef cow-calf enterprises.

TRADEOFFS BETWEEN SYSTEM COSTS AND POLLUTION CONTROL

The monetary costs and qualitative water quality estimates as pollution control components are added to the alternative fed beef and cow-calf beef systems are presented in Tables 25-30.

TABLE 25. FED BEEF, DRY LOT PAVED SYSTEMS, ANNUAL NET SYSTEM RETURNS AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Returns		Level of Pollution[a]		
					Water		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Quantity of Runoff	Quality of Runoff	Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Dry lot, partial shelter, paved, solid spread	Base	100	- 7.47	6.93	4	5	4
	Runoff control-detention/irrigation	100	-13.70	0.70	1	1	4
	Runoff control-grass infiltration	100	- 9.17	5.23	2	2	4
	Base	400	0.78	15.18	4	5	4
	Runoff control-detention/irrigation	400	- 1.17	13.23	1	1	4
	Runoff control-grass infiltration	400	- 0.11	14.29	2	2	4
	Base	700	1.07	15.47	4	5	4
	Runoff control-detention/irrigation	700	- 0.44	13.96	1	1	4
	Runoff control-grass infiltration	700	0.33	14.73	2	2	4

[a] Scale: 1 No Pollution 2 3 4 5 Severe Pollution

TABLE 26. FED BEEF, DRY LOT UNPAVED SYSTEMS, ANNUAL NET SYSTEM RETURNS AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return: At 50 Percent Usage of Nutrients	Net System Return: At 100 Percent Usage of Nutrients	Level of Pollution[a]: Water: Quantity of Runoff	Level of Pollution[a]: Water: Quality of Runoff	Level of Pollution[a]: Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Dry lot, partial shelter, unpaved, solid spread	Base	100	-0.25	13.75	5	5	4
	Runoff control-detention/irrigation	100	-8.58	5.42	1	1	4
	Runoff control-grass infiltration	100	-2.49	11.51	2	2	4
	Base	400	5.62	19.62	5	5	4
	Runoff control-detention/irrigation	400	2.85	16.85	1	1	4
	Runoff control-grass infiltration	400	4.62	18.53	2	2	4
	Base	700	6.28	20.28	5	5	4
	Runoff control-detention/irrigation	700	3.62	17.62	1	1	4
	Runoff control-grass infiltration	700	4.94	18.94	2	2	4

[a] Scale: 1 2 3 4 5
No Pollution (1) — Severe Pollution (5)

TABLE 27. FED BEEF, TOTAL SHELTER, FULLY SLOTTED SYSTEMS, ANNUAL NET SYSTEM RETURNS AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return: At 50 Percent Usage of Nutrients	Net System Return: At 100 Percent Usage of Nutrients	Level of Pollution[a]: Water: Quantity of Runoff	Level of Pollution[a]: Water: Quality of Runoff	Level of Pollution[a]: Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Total shelter, fully slotted, liquid spread, 90-day storage	Base	100	-32.29	-14.72	2	2	5
	Injection	100	-34.39	-14.56	1	1	2
	Base	400	-14.93	2.64	2	2	5
	Injection	400	-14.36	5.47	1	1	2
	Base	700	-14.63	2.94	2	2	5
	Injection	700	-13.80	6.03	1	1	2

[a] Scale: 1 No Pollution 2 3 4 5 Severe Pollution

TABLE 28. FED BEEF, UNPAVED LOT WITHOUT SHELTER, ANNUAL NET SYSTEM RETURNS AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
					Water		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Quantity of Runoff	Quality of Runoff	Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Unpaved lot, no shelter, solid spreading	Base	100	- 5.42	5.52	5	5	3
	Runoff control-detention/irrigation	100	-13.23	- 2.29	1	1	3
	Base	400	4.19	15.13	5	5	3
	Runoff control-detention/irrigation	400	1.02	11.95	1	1	3
	Base	700	2.89	13.83	5	5	3
	Runoff control-detention/irrigation	700	0.14	11.08	1	1	3

[a] Scale: 1 2 3 4 5

No Pollution ... Severe Pollution

Generally, the pollution control technology of grass infiltration controls most of the runoff while adding minimal costs to those systems having exposed lot surfaces. To illustrate the point, consider the paved dry lot for fed beef (Table 25), the unpaved dry lot for fed beef (Table 26), the cow-calf paved lot (Table 29), and the cow-calf unpaved lot (Table 30) systems. Adding the grass infiltration system to any of these systems improves runoff quantity and quality substantially with added annual net system costs of $2 per head or less for the fed beef systems and $3 per head or less for the cow-calf systems.

Using the detention basin/irrigation system is the most effective means of controlling pollution for systems with exposed lot surfaces. Although the monetary costs of detention/irrigation are substantially more than the costs of grass infiltration, it also improves water quality more. For example, compare the two methods of controlling runoff on the fed beef, dry lot unpaved system (Table 26). Adding grass infiltration to the basic 400 head dry lot unpaved system costs $1.09 per head annually ($19.62 - $18.53, Table 26), and water pollution levels improve from a rating of 5 to a rating of 2. Adding the detention/irrigation system further improves water quality to a rating of 1 (no pollution), but annual costs increase $2.77 per head ($19.62 - $16.85, Table 26). The obvious question is whether the more expensive detention/irrigation systems are worth the added costs. This question is especially relevant for small producers who would bear higher per-unit costs with detention/irrigation systems.

For the slotted floor system with pit storage or any other system where waste storage is included, soil incorporation is a very effective method of controlling odor and water pollution. Furthermore, either injection or plowdown can be done while improving returns to the farmer (Table 27).

TABLE 29. BEEF COW-CALF, PASTURE, PAVED LOT, ANNUAL NET SYSTEM RETURNS AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
					Water		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Quantity of Runoff	Quality of Runoff	Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Pasture, paved lot, winter shelter, solid spreading	Base	40	- 5.50	13.55	4	4	2
	Runoff control-grass infiltration	40	- 8.89	10.16	2	2	2
	Base	100	8.13	27.18	4	4	2
	Runoff control-grass infiltration	100	6.62	25.67	2	2	2
	Base	200	11.97	31.02	4	4	2
	Runoff control-grass infiltration	200	10.63	29.68	2	2	2

[a]Scale: 1 No Pollution 2 3 4 5 Severe Pollution

TABLE 30. BEEF COW-CALF, PASTURE, UNPAVED LOT, ANNUAL NET SYSTEM RETURNS AND LEVEL OF POLLUTION CONTROL FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
					Water		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Quantity of Runoff	Quality of Runoff	Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Pasture, unpaved lot, winter shelter, solid spreading	Base	40	- 5.58	13.23	4	4	2
	Runoff control-detention/ irrigation	40	-19.72	-0.91	1	1	2
	Runoff control-grass infiltration	40	- 6.80	12.01	2	2	2
	Base	100	7.81	26.62	4	4	2
	Runoff control-detention/ irrigation	100	0.36	19.17	1	1	2
	Runoff control-grass infiltration	100	6.77	25.58	2	2	2
	Base	200	11.54	30.35	4	4	2
	Runoff control-detention/ irrigation	200	7.24	26.05	1	1	2
	Runoff control-grass infiltration	200	10.35	29.16	2	2	2

[a] Scale: 1 No Pollution, 2, 3, 4, 5 Severe Pollution

SECTION 8

SWINE WASTE MANAGEMENT OPTIONS

The trend in swine production is towards total confinement with hogs under roof. However, at present, only about 20 percent of the hogs raised by 10 percent of the hog farmers in the United States are in total confinement systems (Van Arsdale and Smith, 1974). The shelter plus open-lot facilities, either paved or dirt/partially paved lots, constitute about 60 percent of the total systems. The remaining 30 percent of facilities are pasture with portable shelters.

The major environmental problems with swine production facilities are runoff from open lots and runoff from manure covered cropland and odors. Estimates are that about 112,000 farms, or over 20 percent of the hog farms, have runoff problems (Van Arsdale and Smith, 1974). Of those lots with runoff control problems, open-lot systems constitute 77 percent, pasture systems 18 percent, and confinement systems 5 percent. Proper management is a key to avoiding polluted runoff from manured fields. Odor nuisances have occurred where cropland used for spreading manure is limited and/or near neighbors. Management practices for controlling runoff and minimizing odors will be discussed later.

Swine waste management options consider the two phases of production, the breeding or production of feeder pigs and the feeding. The first includes farrowing, nursery, gestating sows and boars. The feeding operation begins when the pigs are about 40 to 50 lbs and ends when the market weight is about 220 lbs.

Prime concerns in selecting housing and waste handling facilities are feed efficiency, disease control, capital investment required, and annual operating costs. Other important factors affecting the system are climatic conditions, land availability and operator's preference.

WASTE SYSTEMS

Partial housing is frequently used for small breeding operations. Either portable housing rotated to new pastures or paved lots with farrowing houses are common. The portable houses are disinfected and moved to a new pasture between farrowings. Because of the high labor requirements of these types of farrowing, the swine operation is normally small.

The pasture system is depicted in Figure 30. There is no waste handling needed, and the potential for water and odor pollution is low. Capital investment is low in areas with low land prices. Bedding is cleaned out of

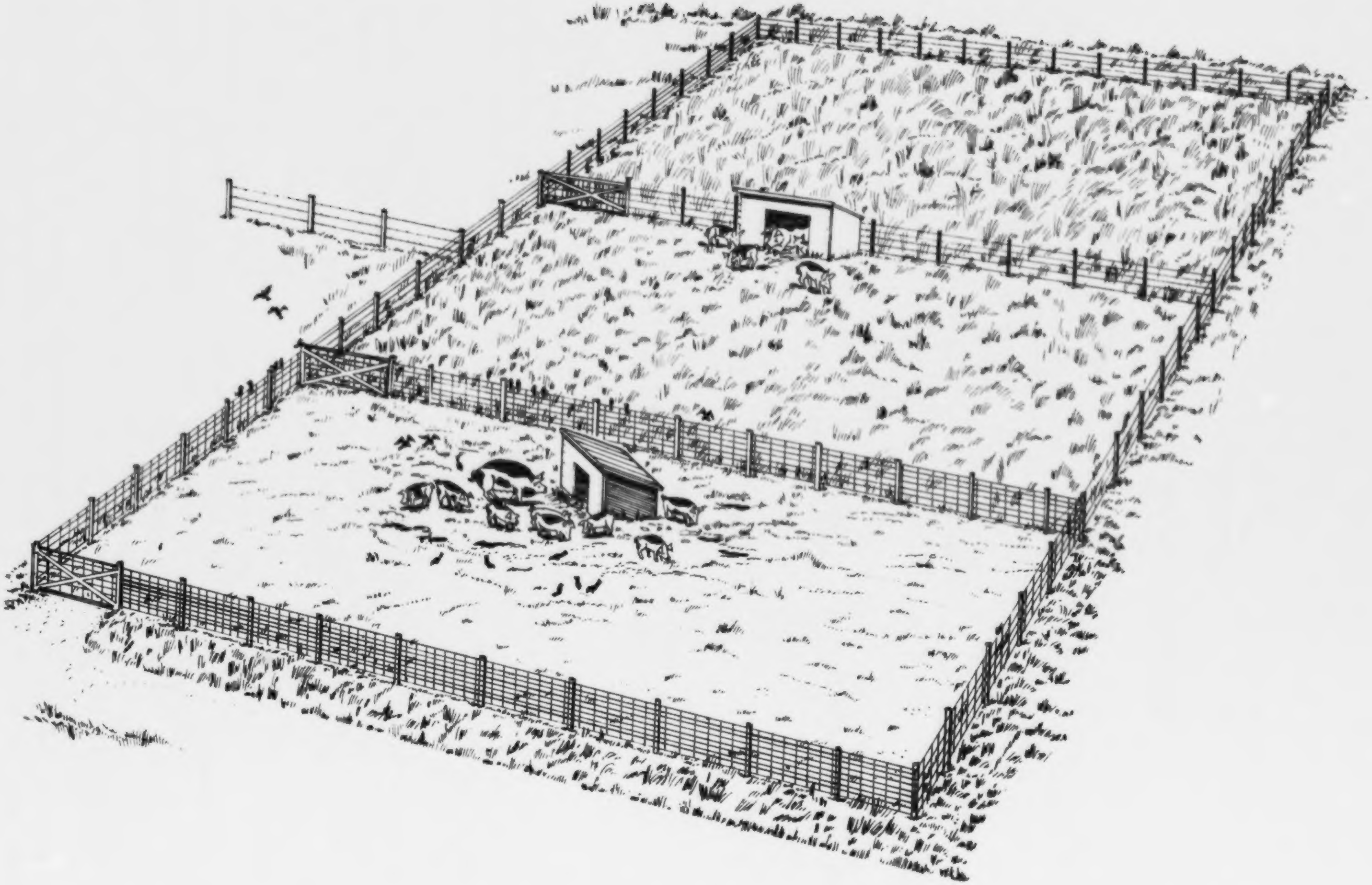

Figure 30. Swine breeding - portable farrowing houses on pasture.

the farrowing houses before moving them to a new pasture. Stocking rate and site selection are primary factors in avoiding pollution.

There should be a complete grass cover present, and fields with flowing streams, wet spots or grassed waterways must be avoided. In periods of high temperature, shade or provision to ventilate the farrowing houses is needed.

The farrowing house on paved lot system is illustrated in Figure 31. The manure dropped on the lot is normally accumulated until the sow and pigs are removed. Then the lots are scraped,with the manure being handled in the solid form. Rainfall runoff is a potential pollution problem. A settling basin and grass infiltration area (Figure 31) can be used to avoid direct runoff into a waterway. Odor nuisance can be a problem during warm and moist weather conditions and additional scraping of solids on the paved lot may be needed. Capital investment and operating costs generally are higher than the pasture system; however, the pigs produced per litter with the paved lot system are higher than the pasture system.

Totally housed farrowing and nursery facilities are common for swine breeding operations. The trend is mostly to slotted floors for the rear portion of the farrowing crate or pen. Some form of liquid waste handling is used with slotted floor systems. Houses with solid concrete floors are used in many facilities. Solid floors require scraping and manure is usually handled as a solid.

The concept of slotted floors with pit storage for farrowing crates and nursery pigs is shown in Figure 32. A vacuum tank wagon is normally used to pump out the pit. The suction hose is inserted into the pump-out port and pushed to the bottom of the pit. If the pits are pumped empty each time, very little sludge will accumulate in the pits. The distance between pump-out ports is a design constraint. Frequently a few inches of water are placed in the bottom of the pit after each emptying to help control odors.

Variations in handling the waste in slotted floor facilities for farrowing are the "V-trough" pit facility with gravity discharge to outside storage or a "trickle tube" or standpipe with over-flow to an outside storage basin. The waste is stored in the outside structure and then hauled to the field or pumped through an irrigation system to the field. Plastic or rubber linings and covers are commercially available for earthen basin to help control odors. In regions of moisture deficit the trickle tube system can be utilized for many years without any spreading of liquid or solids required. When wastes are flushed from beneath slats to an outside treatment lagoon, an irrigation system is normally used for disposal of effluent. The principal environmental concern of these waste systems is disposing of the waste on cropland. Regional application rates and management factors for the land application of manure to avoid pollution should be used. Odor nuisance should not be a problem if proper application methods and management practices are used.

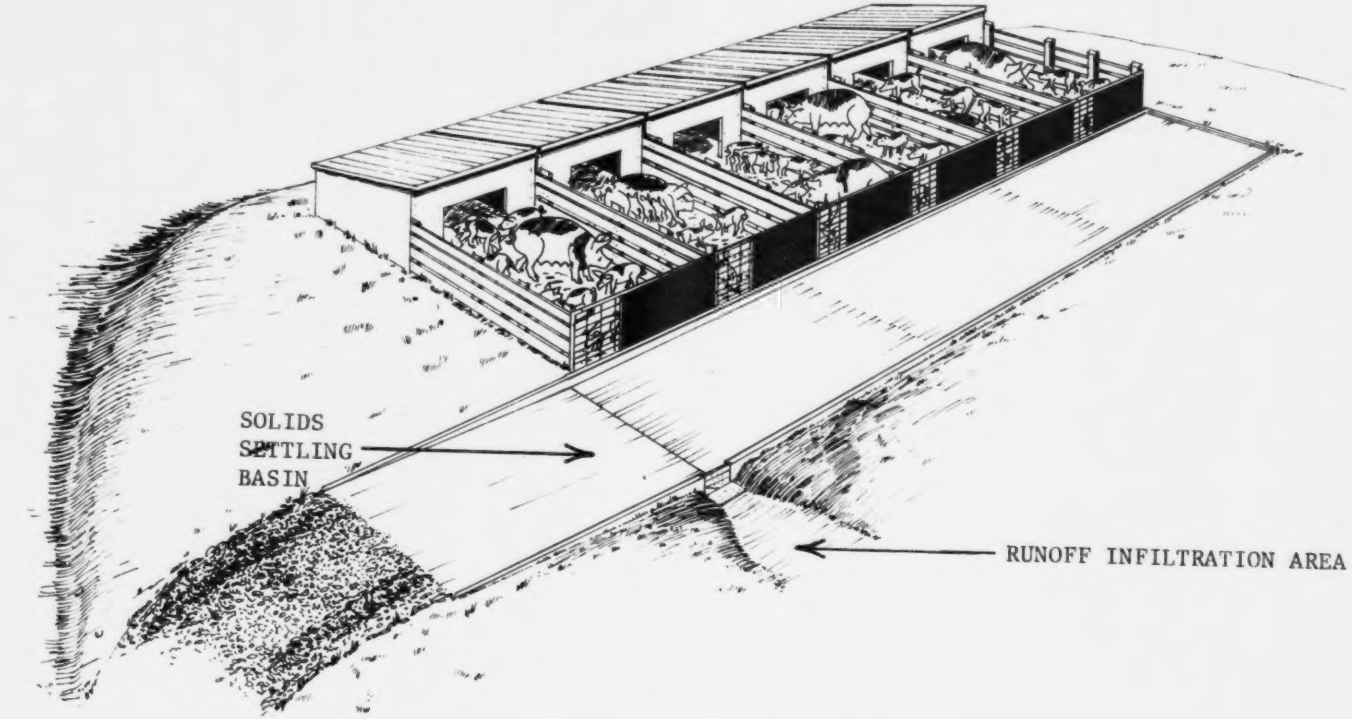
SOLIDS
SETTLING
BASIN
RUNOFF INFILTRATION AREA

Figure 31. Swine breeding - Farrowing house is on paved lot. Manure scraped and handled in solid form. Runoff control includes settling basin and grassed infiltration area.

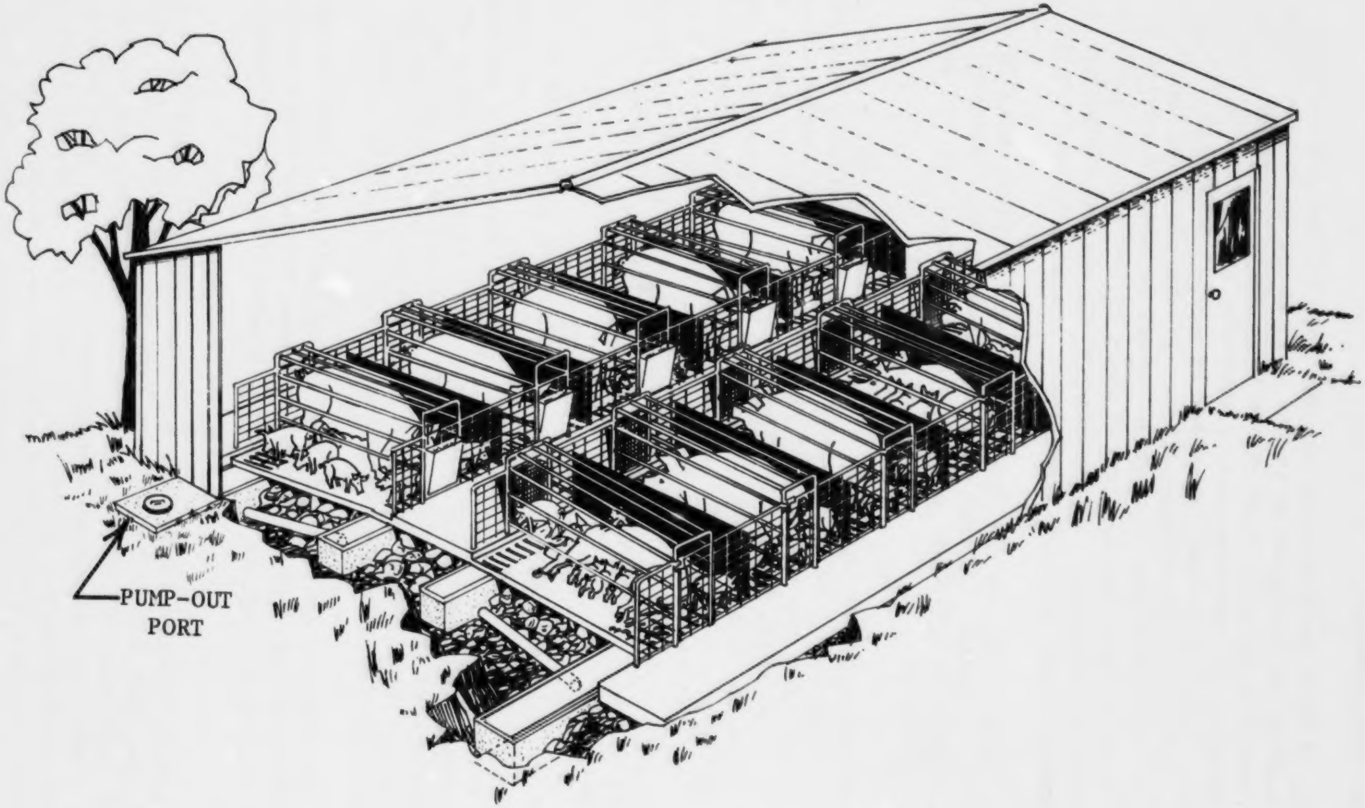
PUMP-OUT
PORT

Figure 32. Confined housing, farrowing crates, partially slotted floor, pit storage, liquid handling.

Three management systems are used for feeding out hogs: pasture, open-lot, and total confinement.

Pasturing of hogs is practiced through much of the humid areas. A recommended loading of 25 market hogs per acre is given by the Midwest Plan Service. Beyond this density, bare spots will begin to appear in the pasture. With rotation of pastures and/or removing animals during the non-growing season, larger stocking rates may be used. Lots with 100 or more hogs per acre will not support vegetation. If the stocking density and management system used maintains vegetative cover, no waste handling is needed. It was noted earlier that 18 percent or about 20,000 pasture systems do have potential pollution problems. By avoiding steep slopes, waterways and streams and using proper pasture management, runoff problems can be minimized

Open-lot systems can be divided into two categories: totally or partially paved and unpaved. In cool and cold humid areas, housing is provided with the open lot. In the warm and hot areas, housing may not be provided, but shade is essential.

Paved lot units typically allow 6 sq ft of shelter and 6 to 20 sq ft of open lot per animal. The solid waste is scraped periodically and spread on cropland. Runoff from the paved lot has high pollutant levels and needs to be managed to avoid polluting surface waters. This type of system and alternative methods of handling the runoff are shown in Figure 33. For swine facilities in the humid areas, the settling basin and grass infiltration area may be the best choice. For large facilities the detention basin with cropland irrigation may be a better choice. For facilities in dry or arid climates, the detention pond with cropland irrigation is commonly used to avoid pollution.

Unpaved or partially paved (feeding pad) units allow 6 sq ft of shelter per animal and widely varying lot densities. These lots do not support vegetative cover. In lots with higher densities, any manure buildup is generally scraped and spread on cropland so that manure packs characteristic of high density beef do not occur. Runoff needs to be controlled as discussed for paved lots. Water infiltrating into the soil can be high in nitrogen,particularly at medium densities (25 to 100 animals/acre).

Total confinement systems may be divided into two major categories: slotted floor with pit storage and solid floor with discharge to outside storage or treatment. Liquid handling characterizes total confinement facilities.

A partially slotted floor with a pit beneath the slats is shown in Figure 34. The area slatted may range from total to about 1/3 of the pen area. Pens less than 1/3 slatted tend to be very dirty and need hand scraping. With proper pen design and management practices, pigs will void their waste on the slatted area. The depth of the pits varies to provide desired storage time. In some cases,additional outside storage is provided. The swine waste stored in the pit is commonly spread on cropland,using a vacuum tank wagon. Withdrawing waste from the ports properly spaced along the

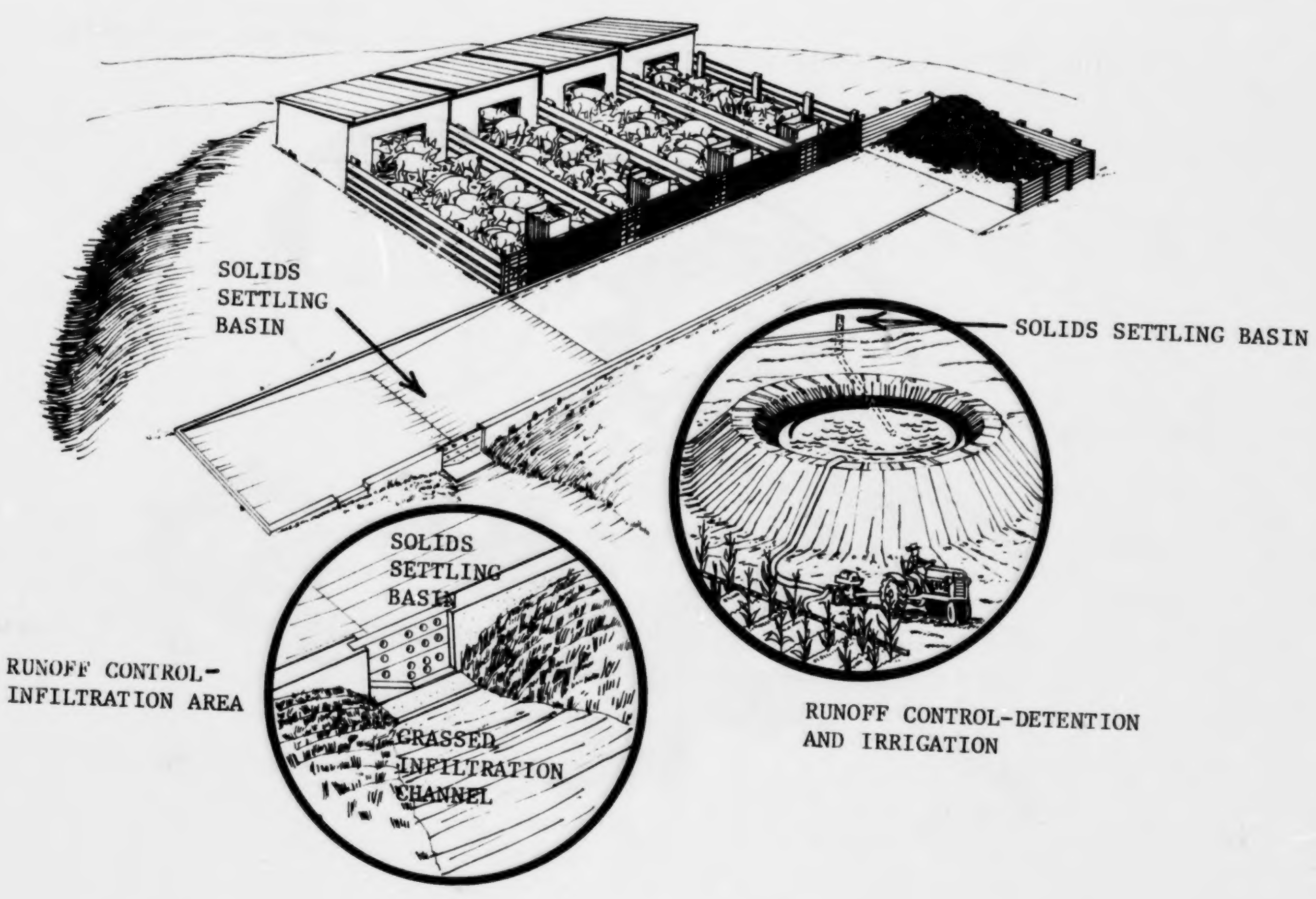
SOLIDS SETTLING BASIN
SOLIDS SETTLING BASIN
SOLIDS SETTLING BASIN
RUNOFF CONTROL-INFILTRATION AREA
GRASSED INFILTRATION CHANNEL
RUNOFF CONTROL-DETENTION AND IRRIGATION

Figure 33. Fed hogs - paved lot with shelter, solid manure handling. Inserts show alternatives for runoff control.

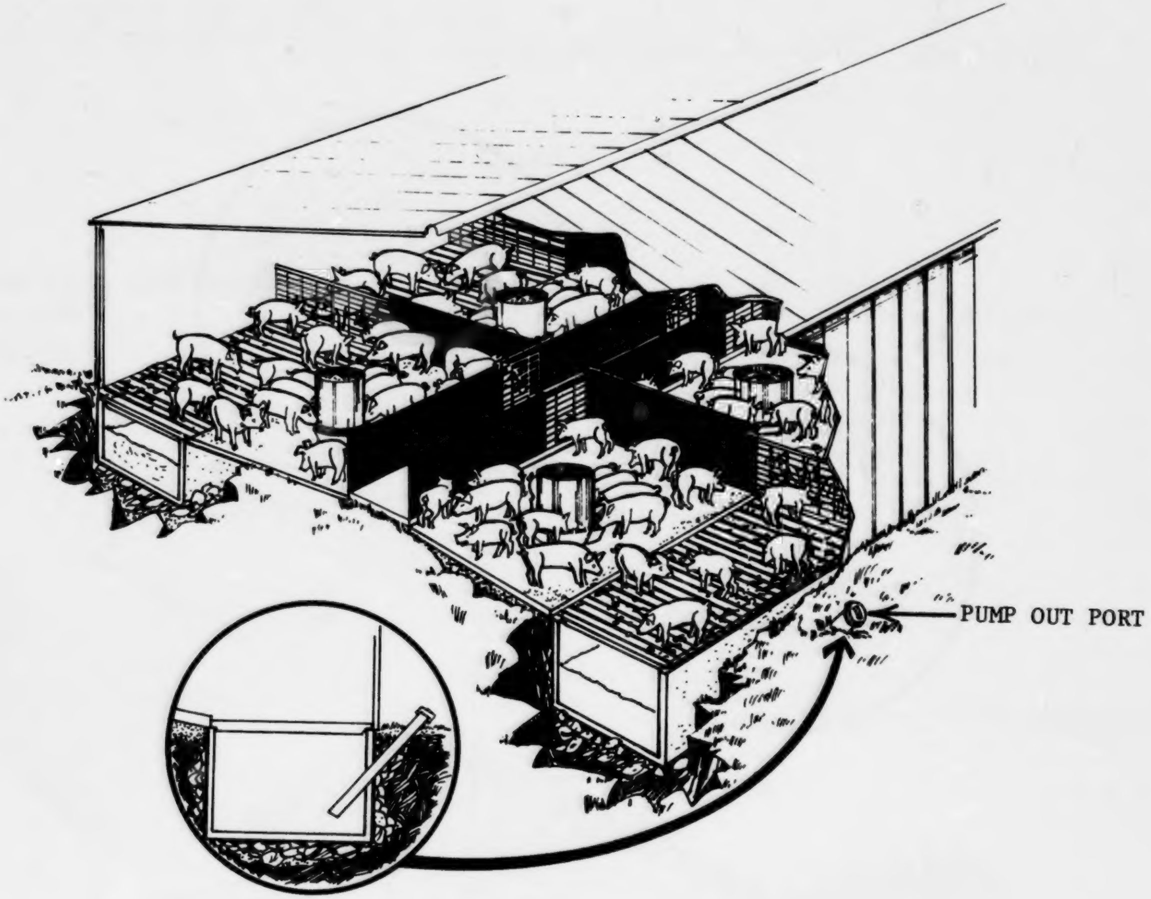
PUMP OUT PORT

Figure 34. Fed hogs - confined, partially slotted floor, pit storage, liquid handling.

length of the pit removes most of the solid, and sludge buildup does not occur.

There are two types of solid concrete floor facilities with discharge to outside storage or treatment. The narrow-gutter system with outside storage is shown in Figure 35. The accumulated wastes in the gutter (several days quantity) is released manually to flow by gravity to the storage tank. Frequently, storage is provided in a concrete tank, although earthen storage basins may be used.

The other solid floor system incorporates a shallow channel which is flushed periodically, every 1 to 4 hours. The flushing water transports the waste to an outside treatment unit. Usually the treatment unit is an anaerobic lagoon system. A two-stage lagoon system is common, shown in Figure 36. Lagoon water is normally recycled for flushing from the second lagoon. For the anaerobic lagoon(s) to function with minimum odor, dilution water from well, roofs or surface runoff is needed. Therefore, provision for irrigating lagoon wastewater on cropland is needed. Design criteria and management requirements for anaerobic lagoons can be found in the Livestock Waste Facilities Handbook, MWPS-18, Midwest Plan Service.

Capital requirements tend to be high for total confinement systems; however, their operating costs are less than those of the open-lot or pasture system. For swine operations located on productive cropland, open-lot and total confinement systems are preferred due to their low land requirements.

With confinement systems come more disease control problems. Generally the level of management must be much higher with confinement systems in order to control disease and control odor and runoff.

OPTIONS TO BE ANALYZED

Swine production is concentrated in the Midwest, Southeast and Texas, with the Midwest providing about two-thirds of the hogs produced. Waste management alternatives are considered for fed hogs and for breeding units.

Breeding Hogs

Facilities for swine breeding have moved increasingly toward confinement. One outside system and four confinement systems with farrowing pens or crates are analyzed.

1. Single farrowing house on paved lot, scrape, solid spread
    - (a) basic system
    - (b) basic system with diversion, settling basin, grass infiltration area
2. Confined, solid floor, scrape, solid spread

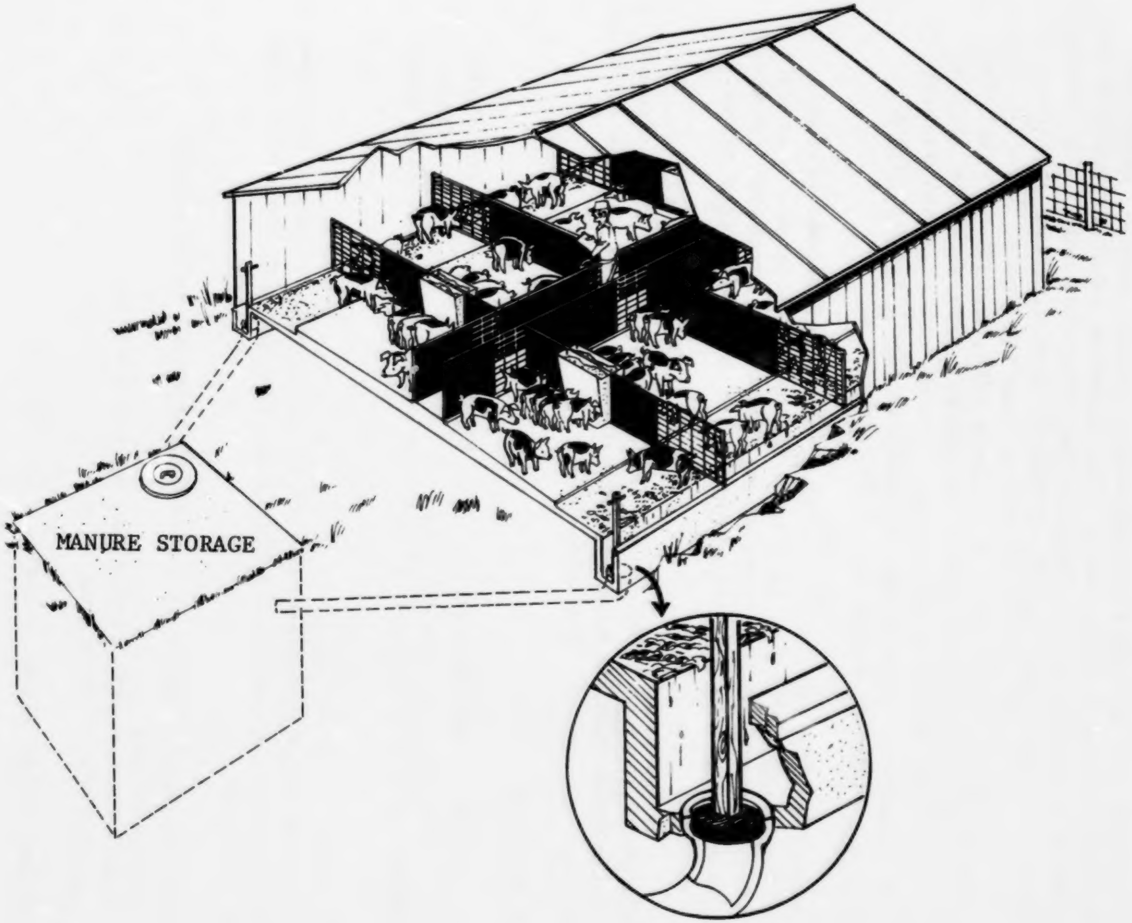
MANURE STORAGE

Figure 35. Fed hogs - confined, concrete floor, narrow gutter, outside storage, liquid handling.

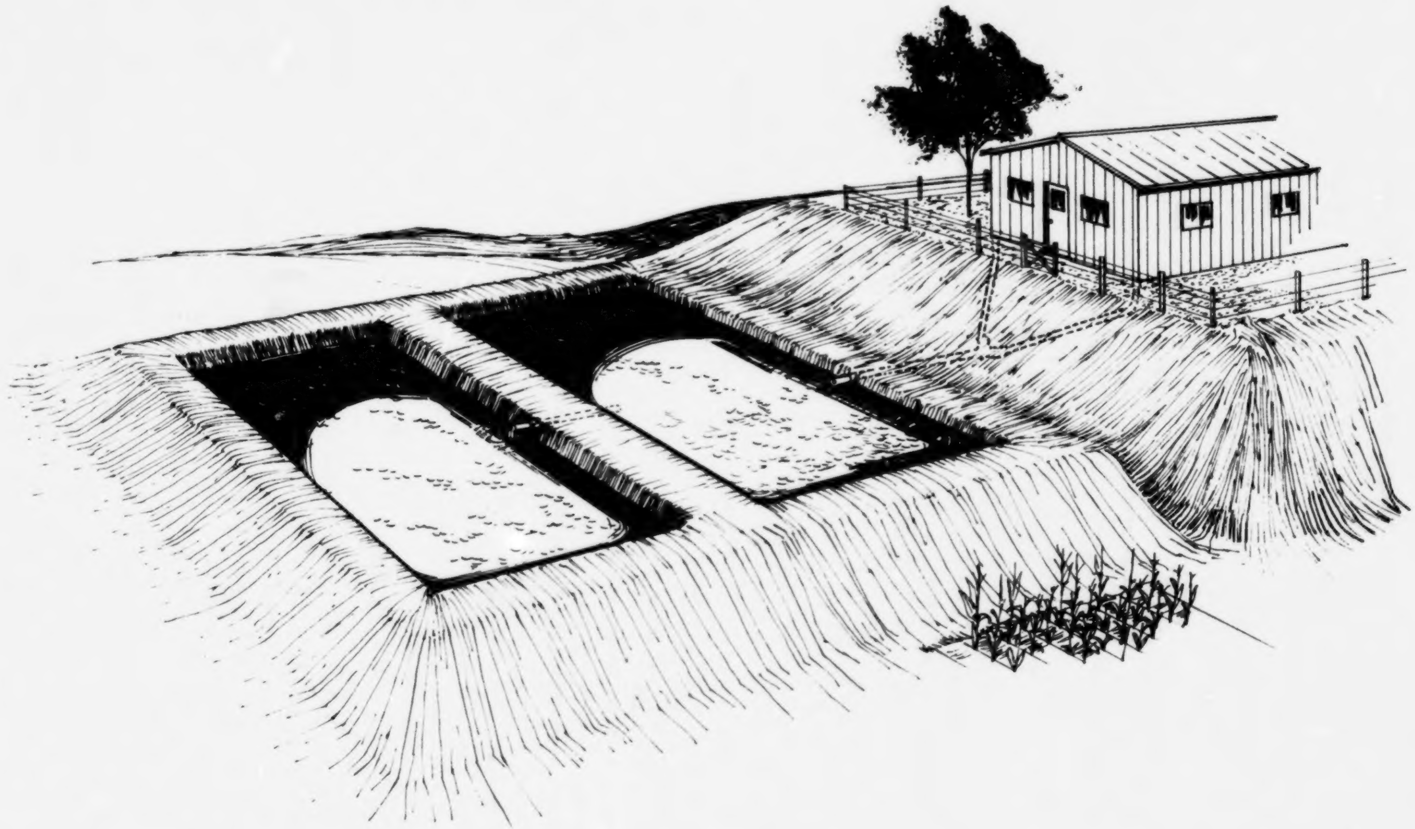

Figure 36. Two-stage anaerobic lagoon system for treatment of wastes flushed from swine building.

3. Confined, partially slotted floor, pit storage, liquid spread
    (a) basic system
    (b) basic system with soil incorporation by injection

4. Confined, partially slotted floor, shallow pit, flush to lagoon, wastewater irrigation

5. Confined, partially slotted floor, flush under slats, lagoon, wastewater irrigation

A sixth swine breeding system is also common where single portable farrowing houses are moved to new pastures for each farrowing. No economic analysis of this system was made since no waste disposal components are required.

Fed Hogs

Two types of fed swine facilities are used, (1) open lot or pasture and (2) total confinement. Three basic open-lot and four basic confinement systems are analyzed along with several pollution control modifications.

1. Unpaved lot, shelter
    (a) base system
    (b) base system with diversion, settling basin, grass infiltration area
    (c) base system with diversion, settling basin, detention, wastewater irrigation
2. Paved lot, shelter
    (a) base system
    (b) base system with diversion, settling basin, grass infiltration area
    (c) base system with diversion, settling basin, detention, wastewater irrigation
3. Unpaved lot, no shelter
    (a) base system
    (b) base system with diversion, settling basin, grass infiltration area
4. Slotted floor, pit storage
    (a) base system
    (b) base system with soil incorporation by injection
5. Partially slotted floor, shallow pit, discharge to lagoon, wastewater irrigation
6. Concrete floor, shallow flushing channel, lagoon, wastewater irrigation
7. Concrete floor, narrow gutter, storage
    (a) base system
    (b) base system with soil incorporation by injection

For unpaved lots, an area of 125 sq ft is used per fed hog. For paved lots, an area of 6 sq ft of outside concrete is used, with another 6 sq ft inside the sheltered area. For hogs in total confinement an average area of 7 sq ft per hog is used.

ECONOMIC ANALYSIS

The following analysis of swine waste management systems includes an estimate of returns and costs for alternative systems. Also, qualitative estimates of society costs are made in terms of water and air quality.

Benefits from Waste

Nitrogen, phosphate and potash losses vary depending on the type of swine waste management system (Table 31). Generally, those systems scraping and loading solid manure from an exposed lot surface have more nutrient losses than those systems where liquid manure is stored. Immediate soil incorporation by injection reduces nutrient losses substantially. On the other hand, a flush system using a lagoon for storage and treatment substantially increases nutrient losses.

Manure production is variable and depends on the ration, weight of the hog, and climate. It is assumed that a fed hog averages 135 pounds on the lot and produces an average of 15 pounds of nitrogen, 17 pounds of phosphate (P_2O_5), and 18 pounds of potash (K_2O) per year. The breeding herd during gestating, farrowing and nursing is assumed to weigh an average of 304 pounds per animal unit. This animal unit produces an average of 40 pounds of nitrogen, 14 pounds of phosphate and 26 pounds of potash per year.

After computing losses due to storage, handling and spreading (Table 31), returns to nutrients are computed by pricing the available nitrogen at $0.16, phosphate at $0.18, and potash at $0.10 per pound. Like other species, two sets of assumptions are used concerning the returns to nutrients: one set uses 100 percent utilization of available nutrients, and the other uses 50 percent utilization.

Analysis of Options

Fed Swine, Paved Lot--

Annual net system costs for this system are shown in Table 32. The basic system results in the lowest annual net system costs,with grass infiltration and detention irrigation systems producing higher costs at each size level. These costs are depicted in Figure 37.

Between swine feedlot capacities of 200 and 1000 head, few economies of size are gained. Thus, the investment outlays in equipment such as spreaders, loaders, and scrapers result in lot capacities of less than 200 head being at a relative disadvantage.

The 50 head capacity system is at a distinct disadvantage under any of the pollution control alternatives. The paved lot system with no runoff control results in annual net system costs of $16.92 per animal year, as seen in Table 32. With a 2.5 turnover rate, waste disposal costs per pig sold

TABLE 31. NITROGEN, PHOSPHATE (P_2O_5), AND POTASH (K_2O) AVAILABLE TO CROPS FROM SWINE WASTE PER ANIMAL UNIT[a] FOR ALTERNATIVE HANDLING SYSTEMS.

System	Nutrients Available to Crops per Animal Unit[b] (lb/yr)		
	Nitrogen	Phosphate (P_2O_5)	Potash (K_2O)
Fed Swine			
Pasture, portable shelter	11	17	18
Unpaved lot, shelter, solid handling	5	8	11
Paved lot, shelter, solid handling	7	12	13
Total shelter, slotted floor, pit, liquid handling	8	15	16
Total shelter, concrete floor, flush lagoon, irrigate	2	8	11
Total shelter, concrete floor, narrow gutter, storage	8	15	16
Total shelter, slotted floor, pit, liquid, soil incorporated	11	17	18
Total shelter, concrete floor, narrow gutter, storage, soil incorporation	11	17	18
Swine Breeding			
Pasture, portable shelter	30	14	16
Paved lot, shelter, solid handling	19	10	20
Total shelter, concrete floor, pen/crate, solid handling	24	13	23
Total shelter, slotted floor, pit, liquid handling	22	13	23
Total shelter, slotted floor, flush, lagoon, irrigate	6	7	16
Total shelter, slotted floor, pit, liquid, soil incorporation	28	14	26

[a] One animal unit: fed hog = 135 lb, swine breeding = 304 lb (sow and litter = 375 lb, gestating sow = 275 lb)

[b] Nutrient production per year:

		N (lbs)		P_2O_5 (lbs)		K_2O (lbs)
Fed swine (135 lb feeder)		15		17		18
Swine breeding		40		14		26
sow with litter (2/7 of year)	24		8		16	
gestating sow (5/7 of year)	16		6		10	

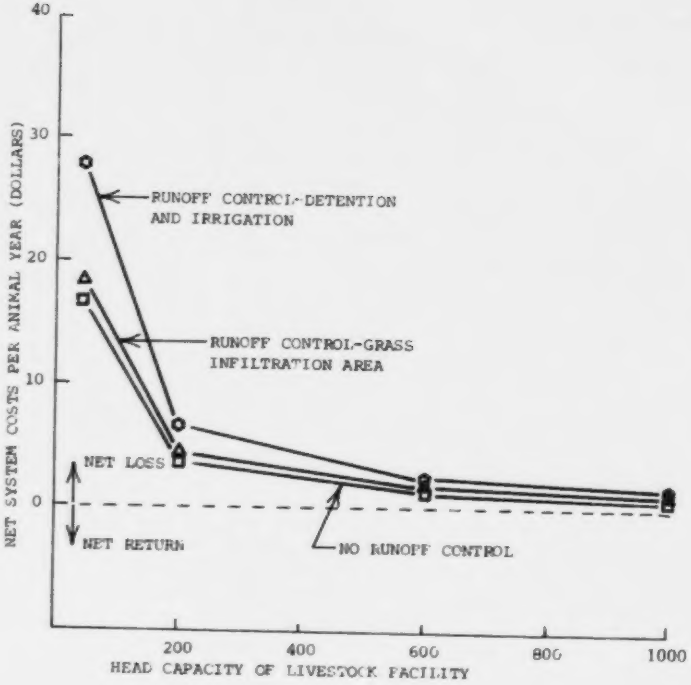

Figure 37. Fed swine, annual net system costs for paved lot with shelter (100 utilization of available nutrients assumed).

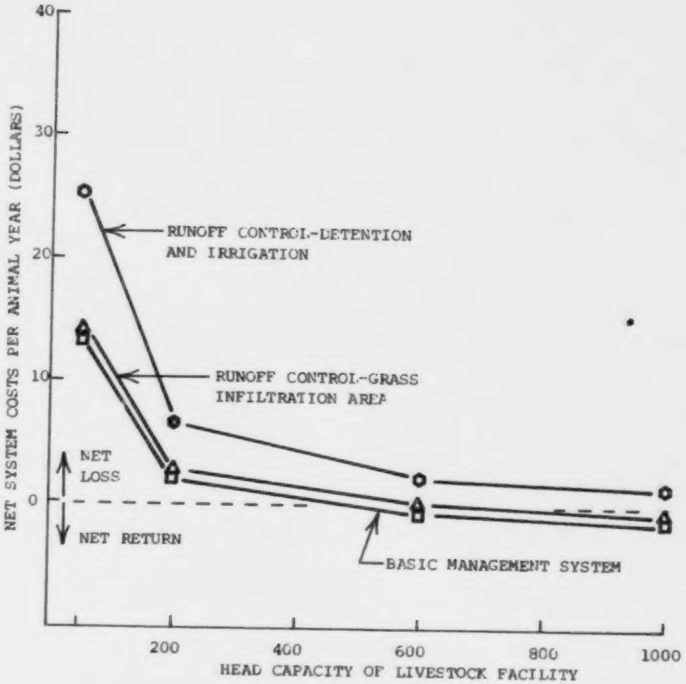

Figure 38. Fed swine, annual net system costs for unpaved lot with shelter (100% utilization of available nutrients assumed).

TABLE 32. FED SWINE, PAVED LOT WITH SHELTER, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients: 50 Percent Usage of Available Nutrients (4)	Returns to Nutrients: 100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	Net System Returns: At 50 Percent Usage of Nutrients (4)-(6)-(7)	Net System Returns: At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Paved lot with shelter	Base	50	2.29	4.58	2.55	18.95	-19.21	-16.92	C-1
	Runoff control-detention/irrigation	50	2.29	4.58	2.95	29.64	-30.31	-28.02	C-2
	Runoff control-grass infiltration	50	2.29	4.58	2.69	20.48	-20.88	-18.59	C-3
	Base	200	2.29	4.58	2.55	5.91	- 6.17	- 3.88	C-4
	Runoff control-detention/irrigation	200	2.29	4.58	2.73	8.71	- 9.15	- 6.86	C-5
	Runoff control-grass infiltration	200	2.29	4.58	2.60	6.42	- 6.73	-4.44	C-6
	Base	600	2.29	4.58	2.55	3.29	- 3.55	- 1.26	C-7
	Runoff control-detention/irrigation	600	2.29	4.58	2.62	4.25	- 4.58	- 2.29	C-8
	Runoff control-grass infiltration	600	2.29	4.58	2.59	3.52	- 3.81	- 1.52	C-9
	Base	1000	2.29	4.58	2.55	2.88	- 3.14	- 0.85	C-10
	Runoff control-detention/irrigation	1000	2.29	4.58	2.60	3.52	- 3.83	- 1.54	C-11
	Runoff control-grass infiltration	1000	2.29	4.58	2.58	3.07	- 3.36	- 1.07	C-12

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[a] Regions: cool humid, cold humid, warm humid, and hot humid

are $6.77. When the grass infiltration area is added, annual net system costs per animal year increase by $1.67, and waste disposal costs per pig sold increase to $7.44. If the detention basin/irrigation system is used costs per animal year increase by $11.10, and costs per pig sold escalate to $11.21.

Annual net system costs per animal year for the 1000 head capacity paved lot with no pollution are approximately $1, and additions of grass infiltration or detention/irrigation increase these costs by less than $1 per animal year.

Fed Swine, Unpaved Lot--

The annual net system costs per animal year for the unpaved lot systems are similar to those for the paved lot systems. Again, substantial economies of size are enjoyed by the moderate to large sized lots due to the lumpiness of the initial investment as shown in Figure 38. Also, the added costs of pollution control are minimal for the grass infiltration system.

For the 50 head capacity lot, costs of the basic system are $13.21 per animal year (Table 33). With the addition of the grass infiltration method of runoff control, costs per animal year increase by $0.90 to $14.11. If the detention/irrigation system is used to control runoff, costs per animal year jump by $12.05 to $25.26.

Comparing these costs for the 50 head capacity lot with those for the 600 or 1000 head capacity lot, economies of size in the detention/irrigation system are noticeable. For the 600 head lot using detention/irrigation, costs per animal unit are $2.33, and costs for the 1000 head lot using detention/irrigation are only $1.41 per animal unit. Thus, if this system were imposed on all lots the larger producer would have a distinct competitive advantage.

On the other hand, the grass infiltration system presents fewer disadvantages to the small producer. The addition of grass infiltration systems increased per animal year costs by $0.90, $0.50, $0.31, and $0.27 for the 50, 200, 600 and 1000 head capacity lots, respectively.

Fed Swine, Unpaved Lot without Shelter--

Limited to warm and hot humid regions of the country, this waste management system requires only small investment outlays. The only initial investment and annual costs of waste management are for land. With land area being 250 sq ft per fed hog, the initial investment is computed at $215 per head capacity,which results in annual costs of $0.47 per animal year.

Due to the large surface area of the lot, using the detention/irrigation system would require massive detention basin volume and result in high initial capital investments. Thus, only the grass infiltration system is considered. For example, with the addition of grass infiltration on the 600 head lot, costs per animal year increase from $0.47 on the basic system to $0.85 (Table 34).

Fed Swine, Total Slats, 6 Month Pit Storage--

Confined feeding operations are increasing in numbers throughout all

TABLE 33. FED SWINE, UNPAVED LOT WITH SHELTER, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients		Variable Costs (6)	Fixed Costs (7)	Net System Returns		Appendix Reference
			50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)			At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	
					(Dollars per Animal Year)				
Unpaved lot with shelter	Base	50	1.17	3.34	1.29	15.26	-14.38	-13.21	C-13
	Runoff control-detention/irrigation	50	1.17	3.34	2.36	26.24	-26.43	-25.26	C-14
	Runoff control-grass infiltration	50	1.17	3.34	1.57	15.89	-15.28	-14.11	C-15
	Base	200	1.17	3.34	1.20	4.17	-3.21	-2.04	C-16
	Runoff control-detention/irrigation	200	1.17	3.34	2.28	7.85	-7.96	-6.79	C-17
	Runoff control-grass infiltration	200	1.17	3.34	1.34	4.53	-3.71	-2.54	C-18
	Base	600	1.17	3.34	1.20	1.71	-0.74	+0.43	C-19
	Runoff control-detention/irrigation	600	1.17	3.34	2.28	3.39	-3.50	-2.33	C-20
	Runoff control-grass infiltration	600	1.17	3.34	1.30	1.93	-1.05	+0.12	C-21
	Base	1000	1.17	3.34	0.92	1.38	-0.13	+1.04	C-22
	Runoff control-detention/irrigation	1000	1.17	3.34	2.00	2.75	-2.58	-1.41	C-23
	Runoff control-grass infiltration	1000	1.17	3.34	0.99	1.57	-0.40	+0.77	C-24

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[a] Regions: cold humid, cool humid, warm humid, hot humid

TABLE 34. FED SWINE, UNPAVED LOT WITHOUT SHELTER, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients		Variable Costs (6)	Fixed Costs (7)	Net System Returns		Appendix Reference
			50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)			At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	
			(Dollars per Animal Year)						
Unpaved lot without shelter	Base	50	0.00	0.00	0.00	0.47	-0.47	-0.47	C-25
	Runoff control-grass infiltration	50	0.00	0.00	0.00	0.95	-0.95	-0.95	C-26
	Base	200	0.00	0.00	0.00	0.47	-0.47	-0.47	C-27
	Runoff control-grass infiltration	200	0.00	0.00	0.00	0.88	0.88	-0.88	C-28
	Base	600	0.00	0.00	0.00	0.47	-0.47	-0.47	C-29
	Runoff control-grass infiltration	600	0.00	0.00	0.00	0.85	-0.85	-0.85	C-30
	Base	1000	0.00	0.00	0.00	0.47	-0.47	-0.47	C-31
	Runoff control-grass infiltration	1000	0.00	0.00	0.00	0.85	-0.85	-0.85	C-32

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[a] Regions: warm humid, hot humid

humid regions. The types of systems are numerous; however, only the predominant types are discussed. One of the more typical confinement systems is the slotted floor construction with a pit beneath the slats. Waste is stored and then hauled to the field by tank wagon to be spread or injected. This system is analyzed using 200, 600, and 1000 head herd sizes and results are shown in Table 35 and Figure 39. Net system costs total $5.84 per animal year for the 200 head capacity lot using surface spreading. These per animal unit costs decline for the larger slotted floor systems using surface spreading to $2.04 and $1.32 per animal year for the 600 and 1000 head capacity lots.

Incorporating the waste by injection is a modification to the slotted floor system. As the investment in injection equipment is nearly the same for the 200 head lot as the 1000 head lot, economies of size are realized. In addition, injecting the waste makes more of the nitrogen available for crops. Thus, for the larger lot sizes, injection actually costs less than surface spreading. Net system costs per animal year on the 1000 head capacity lot using injection are only $0.69, and this is $0.63 per animal year less than the cost for surface spreading.

Fed Swine, Partial Slats, Shallow Pit, Lagoon--
This system is used in warm and hot humid regions. Manure drops through slats to a shallow pit beneath the floor. The manure in the pit is flushed to a lagoon where the wastewater is disposed of by an irrigation system.

Net system costs are similar to the totally slotted floor construction (Table 35 and Figure 39). For the 200 head capacity unit, net system costs are $5.36 per animal year. These per animal year costs drop to $2.89 for the 1000 head capacity unit.

Fed Swine, Solid Floor, Flush Shallow Channel to Lagoon--
Another common confinement system is the solid floor flush channel system. Manure accumulates in a shallow gutter and is removed by flushing to a lagoon. Irrigation equipment is used to spread the treated wastewater on nearby fields. Net system costs range from $5.04 per animal year for the 200 head facility to $1.91 for the 1000 head facility (Table 35 and Figure 40), and these compare favorably with the costs of other confinement systems.

Fed Swine, Solid Floor, Narrow Gutter, Storage Basin--
The lowest cost waste management system for fed hogs in confinement appears to be this system. Gravity moves the accumulated waste from a narrow gutter to a storage basin upon manually opening of the valve. A tank wagon is used to transport the waste to the field where it is either spread or injected.

For the larger herd sizes, this system actually produces a small return. On the 600 head capacity lot using surface spreading, net system returns are $0.55 per animal year, and on the 1000 head capacity lot net returns are $1.63 per animal year (Table 35).

Injecting waste improves returns on the larger lots even when a larger

TABLE 35. FED SWINE, TOTAL SHELTER, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients		Variable Costs (6)	Fixed Costs (7)	Net System Returns		Appendix Reference
			50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)			At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	
					(Dollars per Animal Year)				
Total slats, 6 month pit storage[a]	Surface spread	200	2.79	5.58	1.70	9.72	-8.63	-5.84	C-33
	Injection	200	3.31	6.62	1.81	11.47	-9.97	-6.66	C-34
	Surface spread	600	2.79	5.58	1.04	6.58	-4.83	-2.04	C-35
	Injection	600	3.31	6.62	1.10	7.16	-4.95	-1.64	C-36
	Surface spread	1000	2.79	5.58	1.02	5.88	-4.11	-1.32	C-37
	Injection	1000	3.31	6.62	1.08	6.23	-4.00	-0.69	C-38
Partial slats, shallow pit discharge to lagoon[b]	Base	200	1.43	2.86	0.68	7.54	-6.79	-5.36	C-39
	Base	600	1.43	2.86	0.51	5.65	-4.73	-3.30	C-40
	Base	1000	1.43	2.86	0.47	5.28	-4.32	-2.89	C-41
Solid floor, flush gutter to lagoon[c]	Base	200	1.43	2.86	0.61	7.29	-6.47	-5.04	C-42
	Base	600	1.43	2.86	0.44	4.86	-3.87	-2.44	C-43
	Base	1000	1.43	2.86	0.41	4.36	-3.34	-1.91	C-44
Solid floor, narrow gutter discharge to storage basin[d]	Surface spread	200	2.79	5.58	2.14	6.92	-6.27	-3.48	C-45
	Injection	200	3.31	6.62	2.31	8.67	-7.67	-4.36	C-46
	Surface spread	600	2.79	5.58	1.18	3.84	-2.24	+0.55	C-47
	Injection	600	3.31	6.62	1.30	4.43	-2.42	+0.89	C-48
	Surface spread	1000	2.79	5.58	1.11	2.84	-1.16	+1.63	C-49
	Injection	1000	3.31	6.62	1.17	3.19	-1.05	+2.26	C-50

[a] Regions: cool, cold, warm, and hot humid

[b] Regions: warm and hot humid

[c] cool, warm, and hot humid

[d] cool and cold humid

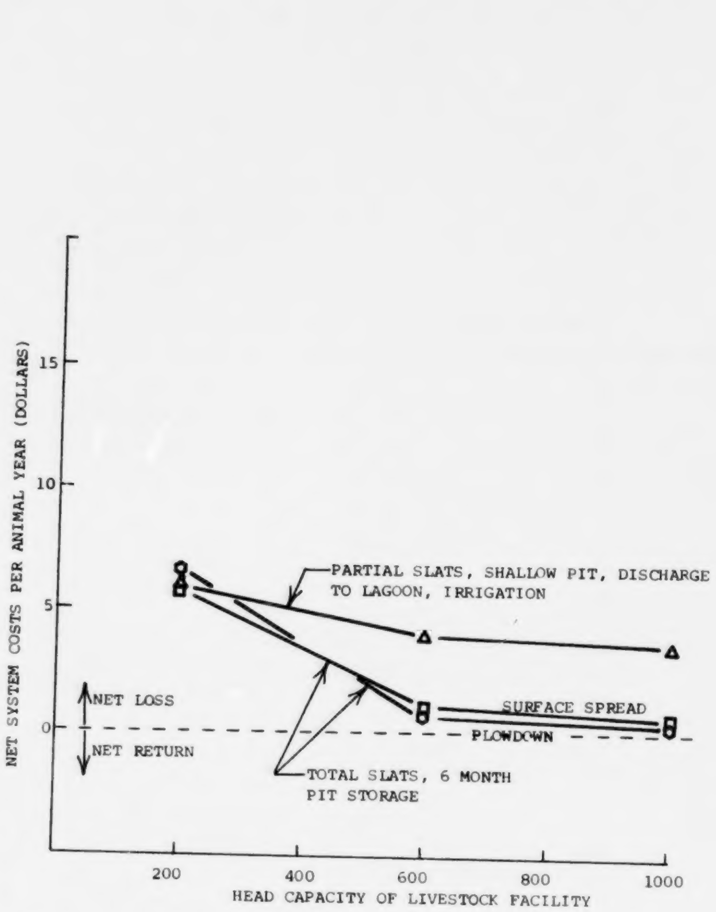

Figure 39. Fed swine, annual net system costs for total slats with pit storage, and partial slats discharging to lagoon (100% utilization of available nutrients assumed).

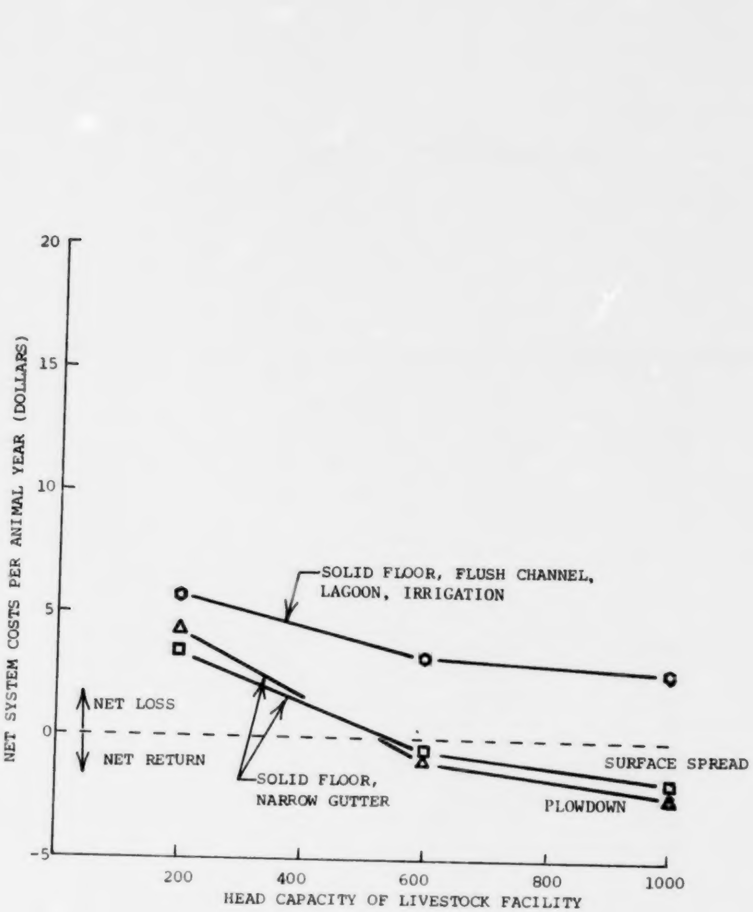

Figure 40. Fed swine, annual net system costs for solid floor with flush channel and solid floor with narrow gutter discharge to storage basin (100% utilization of available nutrients assumed).

initial investment is required. Net system returns are $0.89 per animal year for the 600 head capacity lot, or $0.34 per animal year higher than surface spreading.

Swine Breeding, Paved Lot with Farrowing House--

The outside paved lot with portable farrowing houses is a low cost alternative for breeding herd waste disposal. Annual net system costs are generally below confinement system costs as seen when comparing Figure 41 and 42. These net costs for various capacities of sows only consider costs and returns of the waste system and do not consider the number of pigs produced per litter for each system; thus, it is only a partial analysis.

Annual net system costs per sow for the 20 head lot are nearly double those for the 50 head lot (Table 36). With no pollution control, the paved lot, farrowing house system for 50 head has net disposal costs of $21.06 per animal year and $43.68 per animal year for the 20 head facility, Further economies of size are gained with the 100 head farrowing unit with net costs dropping to $13.52 per animal unit.

Adding the grass infiltration area increases costs slightly with added costs of $3.49 per animal unit for the 20 head lot to $1.11 per animal unit for the 100 head facility.

Swine Breeding, Total Shelter Systems--

Four total shelter systems are considered, and they include the solid concrete floor with farrowing pens, partial slotted floor with 3 month pit storage beneath the floor, partial slotted floor with shallow pit storage flushed to a lagoon for treatment, and partial slotted floor with waste flushing to a lagoon.

The solid floor farrowing pen system offers relatively low annual net system costs compared to other breeding confinement systems. Net system costs range from $48.80 per animal year to $23.50 per animal year for the 20 and 50 sow units, respectively.

Highest waste disposal costs are associated with the partial slotted floor with pit storage. Annual net system costs are from $71.70 per animal unit for 20 sows to $27.11 per animal unit for 100 sows. Unlike most of the other species examined, adding injection increases costs as the increased returns from nutrient availability are small due to the smaller amounts of waste. Added costs for the injection system total $17.47 per animal unit for the 20 sow unit and $3.02 for the 100 sow unit.

The two systems using partial slotted floors with lagoon treatment differ only slightly in terms of their components and net system costs (Table 36). Incorporating the shallow pit into the system is sometimes done in warm humid and hot humid regions. Waste is periodically flushed to a treatment lagoon. With the other lagoon system, regular flushing occurs beneath the slats and requires added investments in a flushing tank and recycle pump.

Annual net system costs are $42.67 per animal unit for the 20 sow capacity facility using shallow pit storage with lagoon treatment. For the

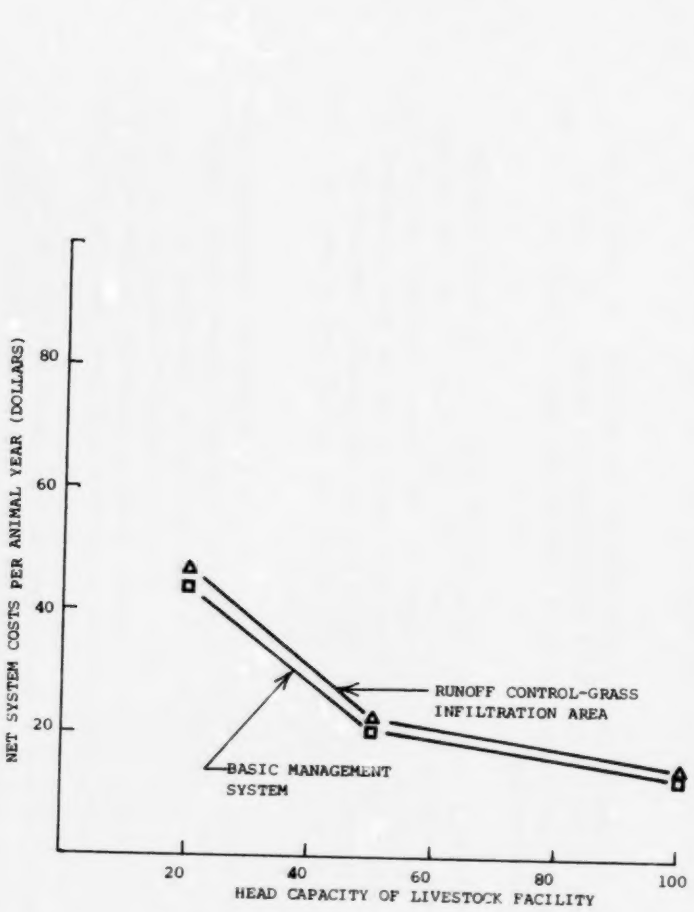

Figure 41. Swine breeding, annual net system costs for paved lot with farrowing house (100% utilization of available nutrients assumed).

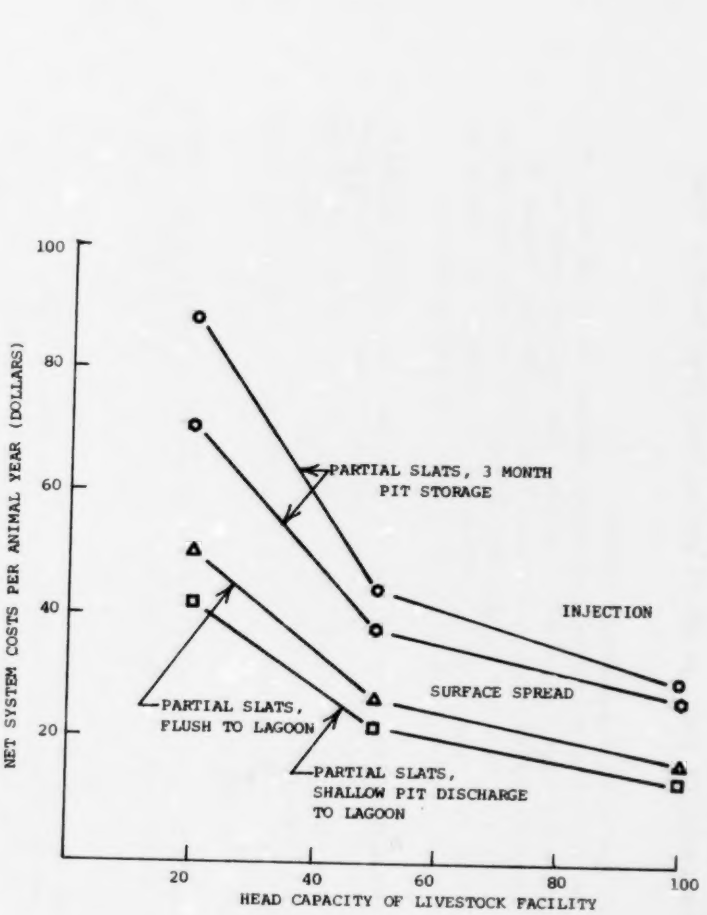

Figure 42. Swine breeding, annual net system costs for total shelter systems (100% utilization of available nutrients assumed).

TABLE 36. SWINE BREEDING, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients		Variable Costs (6)	Fixed Costs (7)	Net System Returns		Appendix Reference
			50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)			At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	
					(Dollars per Animal Year)				
Paved lot with farrowing house	Base	20	1.10	2.20	7.28	38.60	-44.78	-43.68	C-51
	Runoff control-grass infiltration	20	1.10	2.20	7.28	42.09	-48.27	-47.17	C-52
	Base	50	1.10	2.20	4.59	18.67	-22.16	-21.06	C-53
	Runoff control-grass infiltration	50	1.10	2.20	4.59	20.54	-24.03	-22.93	C-54
	Base	100	1.10	2.20	3.70	12.03	-14.62	-13.52	C-55
	Runoff control-grass infiltration	100	1.10	2.20	3.70	13.14	-15.73	-14.63	C-56
Total shelter, concrete floor	Base	20	1.40	2.80	14.56	37.04	-50.20	-48.80	C-57
	Base	50	1.40	2.80	9.18	17.11	-24.90	-23.50	C-58
Total shelter, partial slats, 3 month pit storage	Surface spread	20	1.32	2.64	4.63	69.70	-73.02	-71.70	C-59
	Injection	20	1.62	3.24	5.20	87.21	-90.79	-89.17	C-60
	Surface spread	50	1.32	2.64	4.18	36.68	-39.54	-38.22	C-61
	Injection	50	1.62	3.24	4.41	43.69	-46.48	-44.86	C-62
	Surface spread	100	1.32	2.64	4.07	25.68	-28.43	-27.11	C-63
	Injection	100	1.62	3.24	4.18	29.19	-31.75	-30.13	C-64
Total shelter, partial slats, shallow pit with lagoon	Base	20	0.59	1.18	0.76	43.08	-43.26	-42.67	C-65
	Base	50	0.59	1.18	0.30	24.40	-24.11	-23.52	C-66
	Base	100	0.59	1.18	0.22	17.86	-17.49	-16.90	C-67
Total shelter, flush beneath partial slats to lagoon	Base	20	0.59	1.18	0.76	50.98	-51.15	-50.56	C-68
	Base	50	0.59	1.18	0.30	28.02	-27.74	-27.15	C-69
	Base	100	0.59	1.18	0.22	20.20	-10.83	-19.24	C-70

system using flushing to a treatment lagoon, annual net system costs are $50.56 per animal unit for the 20 sow capacity facility. These per animal unit costs on the 100 sow capacity facility decline to $16.90 and $19.24 for the shallow pit storage and flushing systems, respectively (Figure 42).

LEVEL OF AIR AND WATER POLLUTION FROM SWINE SYSTEMS

For fed swine lots with exposed lot surfaces, water quality may be substantially impaired due to runoff. Uncontrolled runoff from the unpaved open lot or the paved open lot produces high volumes of runoff with high concentration of pollutants as seen in Tables 37, 38 and 39, where lots with controlled runoff receive ratings of "severe pollution". Odor is also a problem on these lots. Adapting either the grass infiltration system or the detention/irrigation system dramatically improves the level of water quality. However, odor problems are unaffected.

Odor problems become less troublesome as densities on exposed lot surfaces decline. For example, all waste management alternatives using paved lot with shelter (12 sq ft per hog) receive an odor rating of "4" (Table 37), while those using the unpaved lot with shelter construction (125 sq ft per hog) receive an odor rating of "3" (Table 38), and those with unpaved lot without shelter (250 sq ft per hog) receive an odor rating of "2" (Table 39).

The total shelter, fully slotted system for fed swine is an effective method of controlling water pollution. Water quality parameters for this system are reduced to 2 in Table 40, indicating potential runoff problems only at times of field spreading manure. Odor problems become more severe, however, with the confinement system. Surface spreading of pit stored waste is often a nuisance to neighbors close by. Soil injection of pit stored wastes not only improves water quality parameters to high levels, but also it reduces the odor nuisance at spreading time.

Both water pollution and odor control are adequate with the partial slats, shallow pit storage, and lagoon system for fed swine (Table 40). The only potential runoff problem occurs at the time of irrigation, and a well managed system should avoid this problem.

Water pollution and odor also are controlled well with the solid floor, flush gutter, lagoon system (Table 40). Slight water pollution occurs at the time of wastewater irrigation, thus water pollution ratings are "2".

The narrow gutter, storage basin system for fed hogs effectively controls water pollution, as seen in Table 40. Odor control problems occur when the storage basin is emptied and spreading occurs. Injection improves water quality and odor parameters to excellent levels.

The paved lot, farrowing house system for breeding swine results in water pollution control problems similar to the exposed lot systems for other species. The grass infiltration area adequately controls any discharge from this system (Table 41). Odor at the time of spreading presents a potential nuisance.

TABLE 37. FED HOGS, PAVED LOT WITH SHELTER, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Water		Odor
					Quantity of Runoff	Quality of Runoff	
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Pave lot with shelter	Base	50	-19.21	-16.92	4	5	4
	Runoff control-detention/irrigation	50	-30.31	-28.02	1	1	4
	Runoff control-grass infiltration	50	-20.88	-18.59	1	1	4
	Base	200	- 6.17	- 3.88	4	5	4
	Runoff control-detention/irrigation	200	- 9.15	- 6.86	1	1	4
	Runoff control-grass infiltration	200	- 6.73	- 4.44	1	1	4
	Base	600	- 3.55	- 1.26	4	5	4
	Runoff control-detention/irrigation	600	- 4.58	- 2.29	1	1	4
	Runoff control-grass infiltration	600	- 3.81	- 1.52	1	1	4
	Base	1000	- 3.14	- 0.85	4	5	4
	Runoff control-detention/irrigation	1000	- 3.83	- 1.54	1	1	4
	Runoff control-grass infiltration	1000	- 3.36	- 1.07	1	1	4

[a] Scale: 1 No Pollution 2 3 4 5 Severe Pollution

TABLE 38. FED SWINE, UNPAVED LOT WITH SHELTER, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Water		Odor
					Quantity of Runoff	Quality of Runoff	
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Unpaved lot with shelter	Base	50	-14.38	-13.21	5	5	3
	Runoff control-detention/irrigation	50	-26.43	-25.26	1	1	3
	Runoff control-grass infiltration	50	-15.28	-14.11	1	1	3
	Base	200	- 3.21	- 2.04	5	5	3
	Runoff control-detention/irrigation	200	- 7.96	- 6.79	1	1	3
	Runoff control-grass infiltration	200	- 3.71	- 2.54	1	1	3
	Base	600	- 0.74	+ 0.43	5	5	3
	Runoff control-detention/irrigation	600	- 3.50	- 2.33	1	1	3
	Runoff control-grass infiltration	600	- 1.05	+ 0.12	1	1	3
	Base	1000	-00.13	+ 1.04	5	5	3
	Runoff control-detention/irrigation	1000	- 2.58	- 1.41	1	1	3
	Runoff control-grass infiltration	1000	-0.40	+ 0.77	1	1	3

[a]Scale: 1 No Pollution 2 3 4 5 Severe Pollution

TABLE 39. FED SWINE, UNPAVED LOT WITHOUT SHELTER, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Water		Odor
					Quantity of Runoff	Quality of Runoff	
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Unpaved lot without shelter	Base	50	-0.47	-0.47	5	5	2
	Runoff control-detention/irrigation	40	-0.95	-0.95	2	2	2
	Base	200	-0.47	-0.47	5	5	2
	Runoff control-detention/irrigation	200	-0.88	-0.88	2	2	2
	Base	600	-0.47	-0.47	5	5	2
	Runoff control-detention/irrigation	600	-0.85	-0.85	2	2	2
	Base	1000	-0.47	-0.47	5	5	2
	Runoff control-detention/irrigation	1000	-0.85	-0.85	2	2	2

[a] Scale: 1 No Pollution, 2, 3, 4, 5 Severe Pollution

TABLE 40. FED SWINE, TOTAL SHELTER, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Water: Quantity of Runoff	Water: Quality of Runoff	Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Total slats, 6 month pit storage	Surface spread	200	-8.63	-5.84	2	2	5
	Injection	200	-9.97	-6.66	1	1	2
	Surface spread	600	-4.83	-2.04	2	2	5
	Injection	600	-4.95	-1.64	1	1	2
	Surface spread	1000	-4.11	-1.32	2	2	5
	Plowdown	1000	-4.00	-0.69	1	1	2
Partial slats, shallow pit, discharge to lagoon	Base	200	-6.79	-5.36	2	2	3
	Base	600	-4.73	-3.30	2	2	3
	Base	1000	-4.32	-2.89	2	2	3
Solid floor, flush gutter to lagoon	Base	200	-6.47	-5.04	2	2	3
	Base	600	-3.87	-2.44	2	2	3
	Base	1000	-3.34	-1.91	2	2	3
Solid floor, narrow gutter discharge to storage basin	Surface spread	200	-6.27	-3.48	2	2	5
	Injection	200	-7.67	-4.36	1	1	1
	Surface spread	600	-2.24	+0.55	2	2	5
	Injection	600	-2.42	+0.89	1	1	1
	Surface spread	1000	-1.16	+1.63	2	2	5
	Injection	1000	-1.05	+2.26	1	1	1

[a] Scale: 1 No Pollution, 2, 3, 4, 5 Severe Pollution

Water pollution is well controlled by confinement systems for breeding swine. For the partial slotted floor pit storage system, incorporation improves water quality and odor parameters to excellent ratings (Table 41). For the partial slotted floor systems with lagoons (Table 42), water pollution problems are negligible. Odor control is generally acceptable with confinement systems, although spreading from pit storage presents some odor nuisance unless incorporation is used.

TRADEOFFS BETWEEN SYSTEM COSTS AND POLLUTION CONTROL

For fed swine on exposed lot systems (Tables 37, 38 and 39), water pollution can be effectively controlled by either the grass infiltration or detention/irrigation system. In areas where grass infiltration is feasible, it should be the recommended water pollution control practice for exposed lot, fed swine systems. Costs are substantially less for the grass infiltration method than for the detention/irrigation system. This cost differential is especially significant for the smaller producer.

When using manure storage (total slats and narrow gutter systems, Table 40) on fed swine systems, soil incorporation by injection slightly improves water quality and significantly reduces odor problems at the time of spreading. For smaller lots, the increased fixed costs in injection equipment are slightly larger than returns from improved nutrient availability, and the farmer bears higher costs with injection. However, on larger lots, net returns actually increase by using injection of stored manure.

For fed swine systems using lagoon treatment, slight water pollution is possible at the time of wastewater irrigation. These systems do an effective job of controlling water pollution and odor nuisance if proper irrigation procedures are followed.

Tradeoffs between levels of pollution and waste system costs for swine breeding operations are similar to those for fed swine operations. Water pollution can be controlled effectively on paved lots with farrowing houses by using the grass infiltration system; furthermore, this method of control is relatively inexpensive.

For total shelter systems using pit storage, injection marginally improves water quality and greatly improves odor control (Table 41). For swine breeding, injection presents added costs of $17.47 per animal unit for the small producer and $3.02 per animal unit for the large producer.

With the partial slat systems using lagoon treatment (shallow pit storage and flush beneath slotted floors, Table 42), waste disposal costs are relatively low and water pollution and odor are controlled reasonably well.

TABLE 41. SWINE BREEDING, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return: At 50 Percent Usage of Nutrients	Net System Return: At 100 Percent Usage of Nutrients	Level of Pollution[a]: Water: Quantity of Runoff	Level of Pollution[a]: Water: Quality of Runoff	Level of Pollution[a]: Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Pave lot with farrowing house	Base	20	-44.78	-43.68	4	4	3
	Runoff control-grass infiltration	20	-48.27	-47.17	1	1	3
	Base	50	-22.16	-21.06	4	4	3
	Runoff control-grass infiltration	50	-24.03	-22.93	1	1	3
	Base	100	-14.62	-13.52	4	4	3
	Runoff control-grass infiltration	100	-15.73	-14.63	1	1	3
Total shelter, concrete floor	Base	20	-50.20	-48.80	2	2	3
	Base	50	-24.90	-23.50	2	2	3
Total shelter, partial slats, 3 month pit storage	Surface spread	20	-73.02	-71.70	2	2	3
	Injection	20	-90.79	-89.17	1	1	1
	Surface spread	50	-39.54	-38.22	2	2	4
	Injection	50	-46.48	-44.86	1	1	1
	Surface spread	100	-28.43	-27.11	2	2	4
	Injection	100	-31.75	-30.13	1	1	1

[a] Scale: 1 No Pollution, 2, 3, 4, 5 Severe Pollution

TABLE 42. SWINE BREEDING, NET SYSTEM RETURNS AND LEVEL OF POLLUTANTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return: At 50 Percent Usage of Nutrients	Net System Return: At 100 Percent Usage of Nutrients	Level of Pollution[a]: Water: Quantity of Runoff	Level of Pollution[a]: Water: Quality of Runoff	Level of Pollution[a]: Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Total shelter, partial slats, shallow pit with lagoon	Base	20	-43.26	-42.67	2	2	3
	Base	50	-24.11	-23.52	2	2	3
	Base	100	-17.49	-16.90	2	2	3
Total shelter, flush beneath partial slats to lagoon	Base	20	-51.15	-50.56	2	2	3
	Base	50	-27.74	-27.15	2	2	3
	Base	100	-19.83	-19.24	2	2	3

[a] Scale: 1 No Pollution, 2, 3, 4, 5 Severe Pollution

SECTION 9

SHEEP WASTE MANAGEMENT OPTIONS

Sheep production trends are toward fewer but larger flocks. Production facilities may be categorized into pasturing of ewes-lambs, confinement of ewes-lambs to lots and feeding lambs in high density lots. With many of the smaller ewe flocks the facility may be used to feed out the lambs born to the ewes.

The major pollution problem is control of runoff from feedlots. Depending on the size of the lot and the climatic region, the detention basin-irrigation system or the settling basin-grassed infiltration system may be used. In a few facilities sheep and feeder lambs are raised on slotted or expanded metal floors and the waste generated may need to be incorporated into the soil to control odors. Normally sheep manure is handled in the solid form, because the waste has a higher percent of total solids than that for other animals.

WASTE SYSTEMS

Ewes and lambs are pastured during the summer months and either wintered in barns in heavy snow areas or wintered in milder areas on pasture by grazing regrowth and baled forage. Ewes on winter pasture, supplemented with round hay bales, are illustrated in Figure 43. The pollution problems due to runoff should be minimal. Ewes wintering in an open building with unpaved lot is another system (Figure 44). Rainfall runoff control is needed for such lots.

Both ewe flocks and feeder lambs may be raised on expanded metal (or slotted) floor. Manure collects in a pit beneath the floor and may be mechanically scraped to a storage area or to a box spreader. If the manure is to be handled as a slurry some dilution water is needed. Ewes and lambs need 11 sq ft of floor area per animal unit, and feeder lambs require 5 sq ft of floor area per head.

Feeder lambs are commonly raised in unpaved feedlots without shelter in the warm arid and hot arid regions (Figure 45). Manure is scraped periodically from the lot surface and spread directly on cropland or stockpiled for later spreading. A settling detention basin system is shown for containing runoff which then may be irrigated onto cropland. In colder climates, shelter is normally provided similar to that shown for ewes in Figure 44.

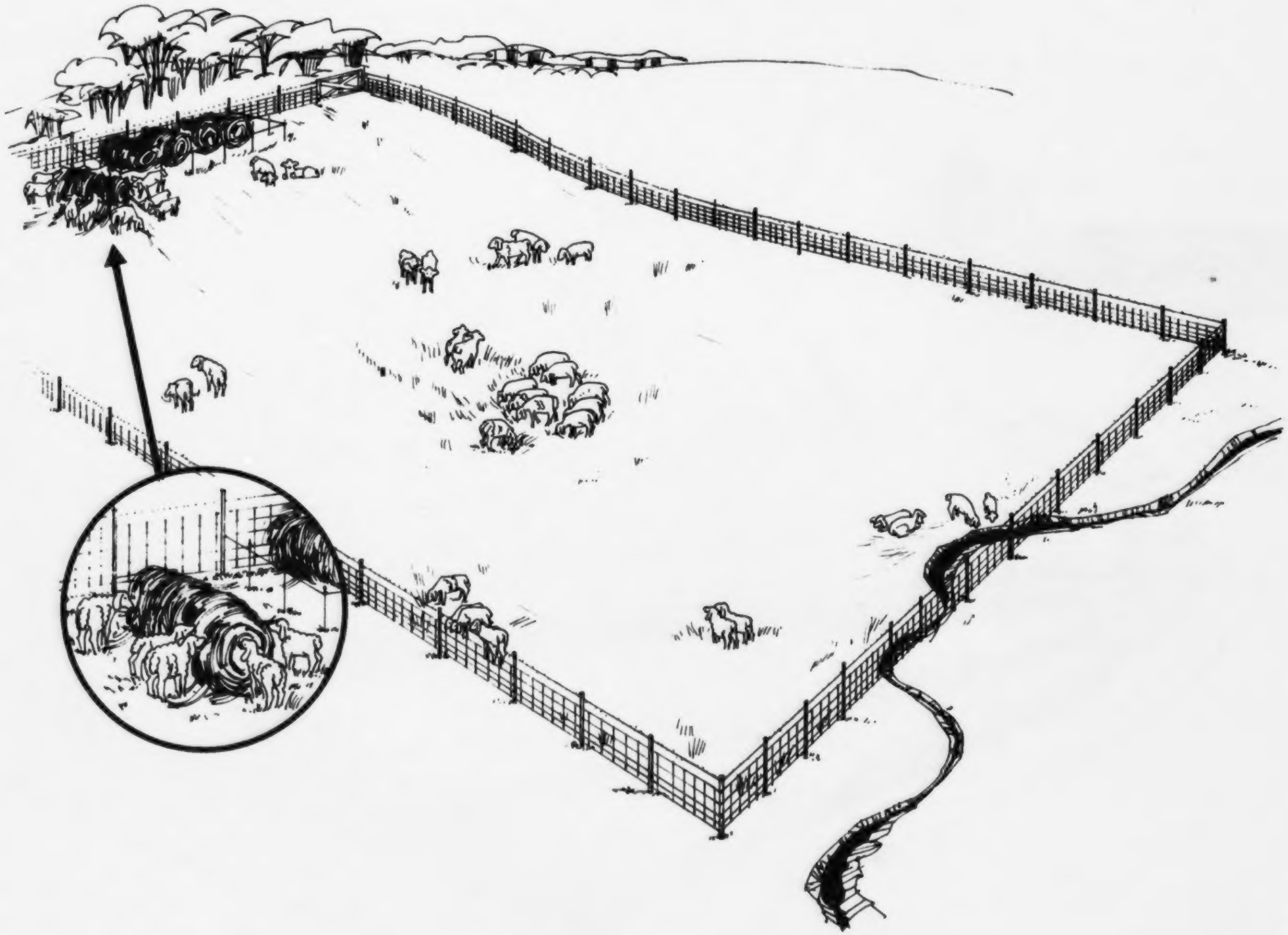

Figure 43. Ewes wintering on regrowth and field stored hay.

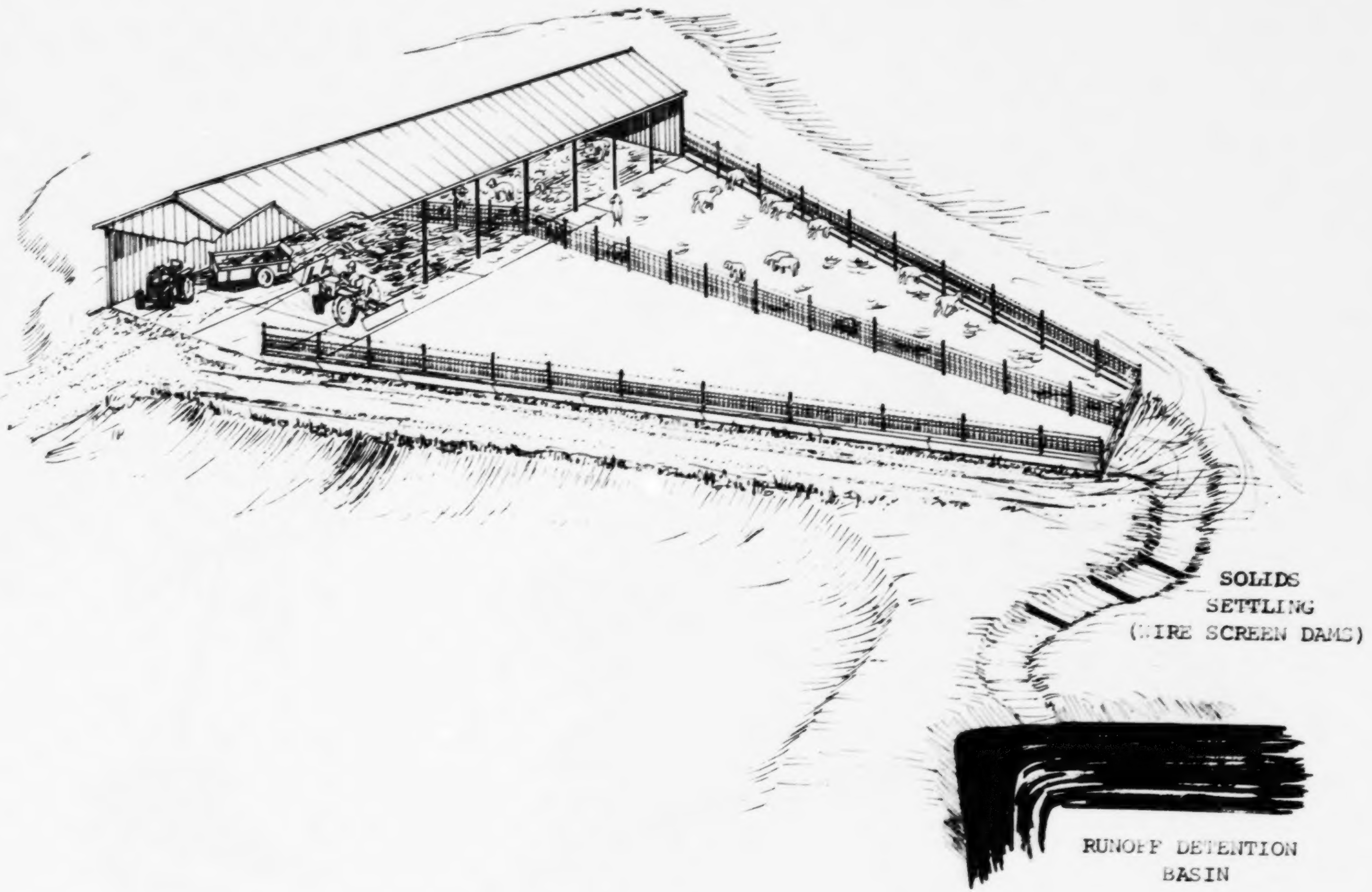
SOLIDS
SETTLING
(WIRE SCREEN DAMS)
RUNOFF DETENTION
BASIN

Figure 44. Ewes wintering in open building with unpaved lot. Manure removed in spring.

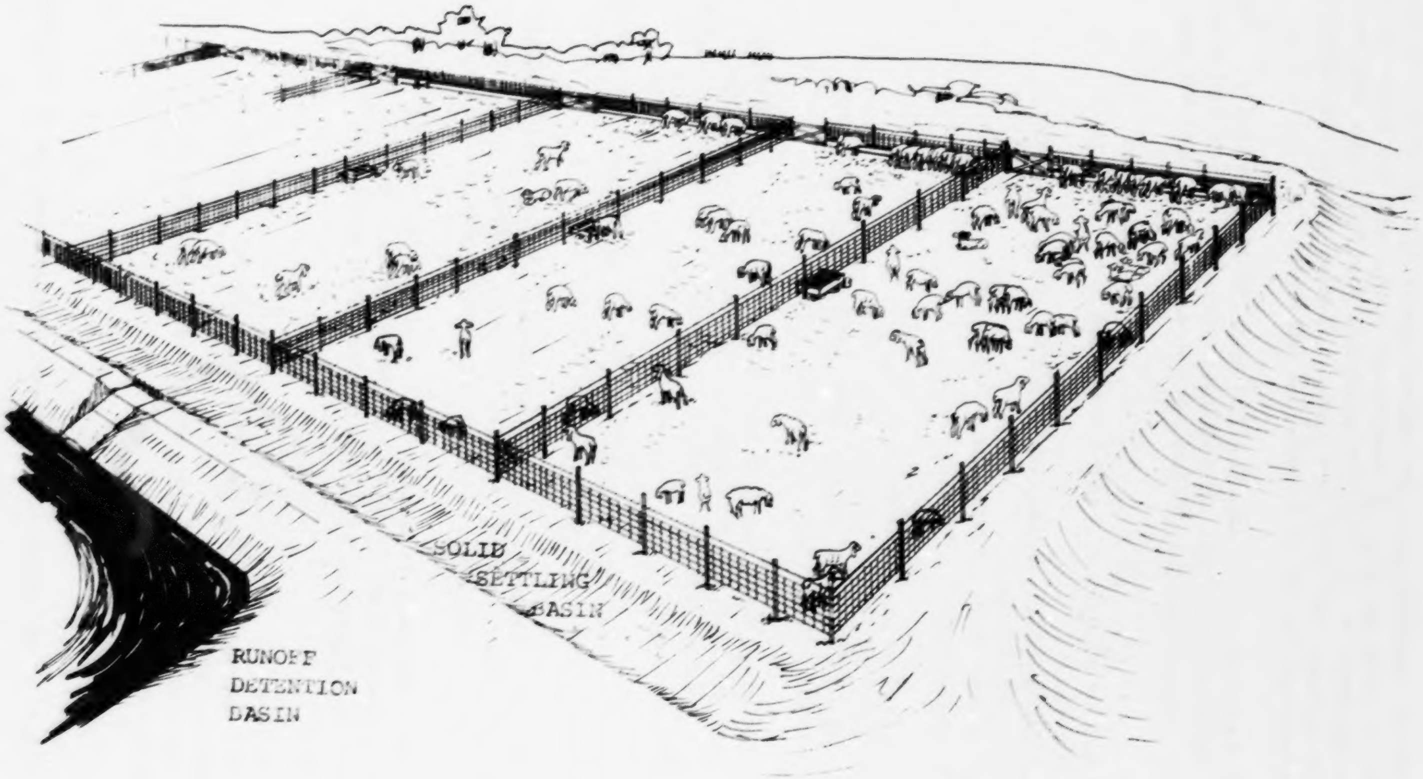
SOLID
SETTLING
BASIN
RUNOFF
DETENTION
BASIN

Figure 45. Fed lambs on open, dry lot. Manure is scraped and removed once or twice a year.

OPTIONS ANALYZED

Facilities may be categorized into summer pasturing of ewes and lambs, winter confinement of ewes in open or sheltered lots, and fed lambs in lots. Three basic waste management systems are analyzed for fed lambs and two winter confinement systems for ewes and lambs. Summer pasturing requires no waste disposal system and is omitted from the analysis.

Ewe and lamb facility sizes are for 150 and 750 head capacity. The facility is used approximately six months each year with pasturing during the summer months. Costs for the following ewe-lamb waste systems are analyzed:

1. Unpaved lot with shelter, solid handling
   (a) base system
   (b) base system with diversion, settling basin, lagoon, wastewater disposal
   (c) base system with diversion, settling basin, grass infiltration area

2. Unpaved lot with no shelter
   (a) base system
   (b) base system with diversion, settling basin, lagoon, wastewater irrigation

An area of 30 sq ft of unpaved lot for each ewe-lamb unit is assumed. For the unpaved lot with no shelter, the runoff control option is limited to the lagoon/irrigation system since the system is found in arid regions not supporting grass infiltration.

Fed lamb facility sizes of 200, 1000 and 5000 head capacity are evaluated for the following basic waste handling systems:

(1) Paved lot with shelter, tractor scraper/loader, solid spread
(2) Unpaved lot with shelter, tractor scraper/loader, solid spread
(3) Unpaved lot, no shelter, tractor scraper/loader, solid spread

Areas per fed lamb used in analyzing the above facilities are 6 sq ft for inside paved floors, 6 sq ft for outside paved lot, and 30 sq ft for unpaved lot. The following rainfall runoff control modifications are evaluated for each system:

(a) basic system
(b) basic system with diversion, settling basin, lagoon wastewater disposal
(c) basic system with diversion, settling basin, grass infiltration area

ECONOMIC ANALYSIS

The vast majority of concentrated sheep operations use an unpaved exposed lot area but some paved lots are used. Waste is scraped and hauled from the lot periodically. Relatively few totally enclosed confinement operations are in use. Thus, the analysis focuses on these unpaved and paved open lot systems. Nutrient value, system costs, and qualitative estimates of water and air quality are analyzed.

Benefits from Waste

Due to the exposed nature of sheep lots, nutrient losses are high. For example, the feeder lamb operation having an unpaved lot with shelter has a 57 percent loss in nitrogen, 29 percent loss in phosphate (P_2O_5), and a 25 percent loss in potash (K_2O). Furthermore, losses are similar over the three feeder lamb systems and the same for the two ewe and lamb systems (Table 43).

As with other species, nutrients are valued according to quantities utilized by crops. Nutrient losses are computed which gives the amounts of available nitrogen, phosphate, and potash. Values are calculated either 100 percent or 50 percent of these available nutrients being utilized by the crops. Unit prices for nutrients are \$0.16 per pound for nitrogen, \$0.18 for phosphate, and \$0.10 for potash.

Analysis of Options

Ewes and Lambs, Unpaved Lot with Shelter--

With no pollution control components on the unpaved lot system, annual net system costs range from \$7.40 per animal year on the 150 ewe facility to \$0.90 per animal year for 750 ewes (Table 44). This large variation is due to declining average fixed costs as herd sizes become larger. Variable costs and returns to nutrients are nearly constant for all sizes (Table 44).

The addition of the detention-irrigation system is an expensive option for controlling runoff. Disposal costs per animal year increase by \$3.63 per animal year (\$11.23 - \$7.60, Table 44) or about 46 percent for the small lot. For the 750 ewe lot, disposal costs increase by \$1.40 per animal year (\$2.29 - \$0.90, Table 44).

As seen in Figure 46, pollution control costs are minimal when the grass infiltration system is used. Disposal costs increase by less than 3 percent for all herd sizes.

Ewes and Lambs, Unpaved Lot without Shelter--

The net system costs for the unpaved lot system without shelter are approximately the same as those of the unpaved lot with shelter. Small differences exist due to the slight difference in sizing of waste management components. For example, annual net system costs are \$6.96 per animal unit for the 150 head flock not having shelter (Table 45) and \$7.40 per animal unit for the 150 head flock with shelter (Table 44 and Figure 47).

These systems cannot be compared directly since they are found in different regions. The unpaved lot without shelter is found in warm and hot

TABLE 43. NITROGEN, PHOSPHATE (P_2O_5) AND POTASH (K_2O) AVAILABLE TO CROPS FROM SHEEP WASTE, PER ANIMAL UNIT[a] FOR ALTERNATIVE HANDLING SYSTEMS

System	Lbs/Year Available to Crop/Animal Unit[b]		
	Nitrogen	Phosphate (P_2O_5)	Potash (K_2O)
Feeder Lambs			
Unpaved lot, no shelter, solid	4.0	1.9	6.1
Unpaved lot, shelter, solid	4.8	2.7	7.6
Paved lot, shelter, solid	5.3	2.7	7.6
Ewes and Lambs			
Unpaved lot, shelter, solid	8.3	4.5	12.7
Unpaved lot, no shelter, solid	6.3	3.0	9.5

[a] One animal unit = 70 lb feeder lamb or 160 lb ewe and lamb.

[b] Nutrient production per year:

	N (lbs)	P_2O_5 (lbs)	K_2O (lbs)
70-lb feeder lambs	11.2	3.8	10.1
150-lb ewe and lamb	17.6	6.0	15.9

TABLE 44. SHEEP, EWES AND LAMBS, UNPAVED LOT WITH SHELTER, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS[a]

			Returns to Nutrients				Net System Returns		
Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Unpaved lot, shelter, solid handling	Base	150	1.74	3.48	2.27	8.61	- 9.14	- 7.40	D-1
	Runoff control-detention/ irrigation	150	1.74	3.48	2.60	12.44	-12.97	-11.23	D-2
	Runoff control-grass infiltration	150	1.74	3.48	2.27	8.81	- 9.34	- 7.60	D-3
	Base	750	1.74	3.48	1.66	2.72	- 2.64	- 0.90	D-4
	Runoff control-detention/ irrigation	750	1.74	3.48	1.87	3.91	- 4.03	- 2.29	D-5
	Runoff control-grass infiltration	750	1.74	3.48	1.66	2.82	- 2.74	- 1.00	D-6

[a] Regions: cold humid, cool humid, cold arid, cool arid.

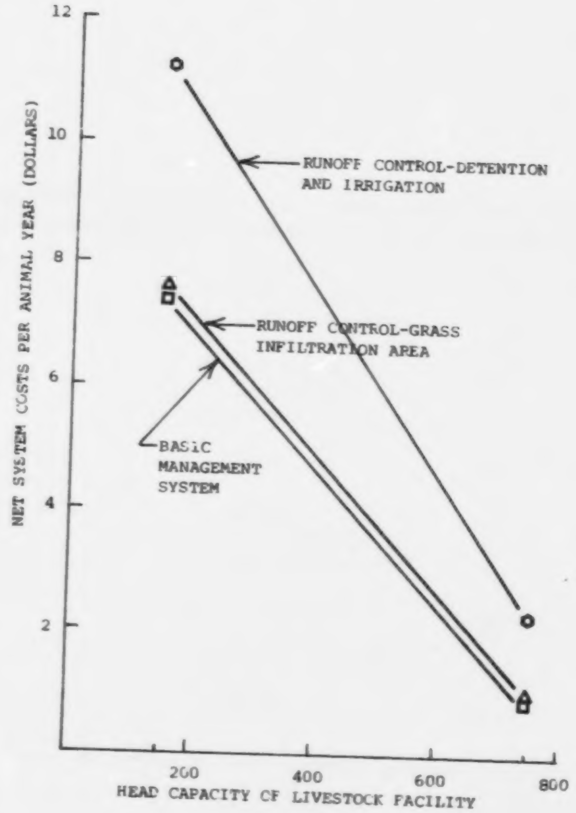

Figure 46. Ewes and lambs, net system costs for unpaved lot with shelter (100% utilization of available nutrients assumed).

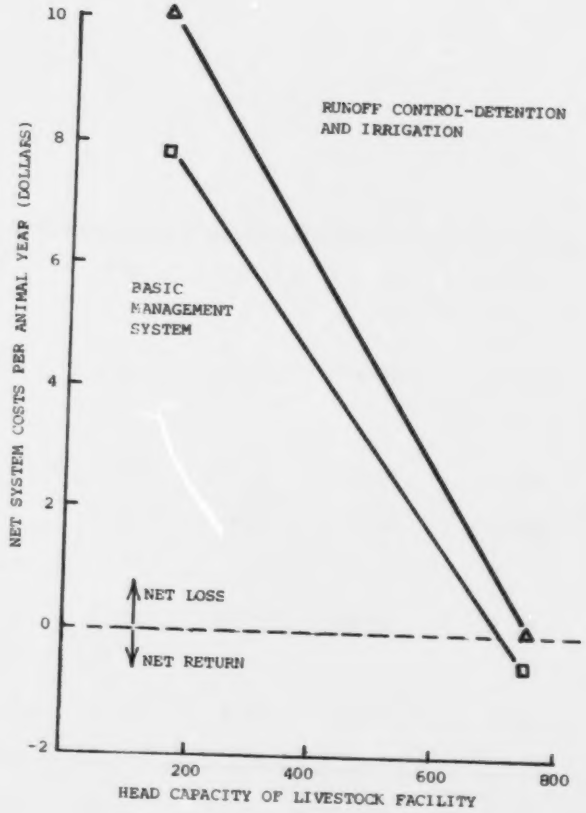

Figure 47. Ewes and lambs, annual net system costs for unpaved lot without shelter (100% utilization of available nutrients assumed).

arid regions while shelter is provided in cold and cool humid and cool arid regions.

For the unpaved lot without shelter, the addition of a detention-irrigation system is the assumed method of runoff control. Since the location is primarily arid regions, it is assumed that the producer would have an irrigation system to empty the limited quantities of runoff which might build up in the detention basin. Thus, costs of pollution control do not contain fixed costs of irrigation equipment. As a result, the detention-irrigation system costs only $2.30 per animal unit ($ 9.26 - $6.96, Table 45) for the 150 head flock and $0.60 ($1.05 - $0.45, Table 45) for the 750 head flock. Caution should be used in extrapolating these costs of runoff control to all producers since some producers may not have irrigation equipment currently in place.

Fed Lambs, Paved Lot--

Again, lumpiness of capital investments results in high fixed costs for the small sheep feedlot producer. The 200 head lot has annual net system costs of $5.36 per animal year on the paved lot, while the net costs for the 5000 head lot are $0.15 per animal year (Table 46). Grass infiltration increases these costs slightly. Costs of grass infiltration pollution control are $0.44 per animal year ($5.80 - $5.36, Table 46) and $0.08 per animal year ($0.23 - $0.15, Table 46) for the small and large lots, respectively.

The basic system of paved lot with shelter is found in cool and cold humid areas. The detention-irrigation runoff control component could be used on these lots, but costs would be prohibitive on small lots. Thus, grass infiltration is the only runoff control system analyzed for the three sizes of paved lots (Figure 48).

Costs for detention-irrigation runoff control are estimated for the 5000 head capacity lot. Costs increase on the 5000 head lot by $0.18 per animal year ($0.33 - $0.15, Table 46) with the detention-irrigation component and $0.08 per animal year ($0.23 - $0.15, Table 46) with the grass infiltration component.

Fed Lambs, Unpaved, with Shelter and without Shelter--

The unpaved lot with shelter and the unpaved lot without shelter have almost identical waste disposal costs. Basically, these systems vary only with respect to the region of the country in which they are used, with the no shelter systems found primarily in warm and hot arid regions. Again, significant economies of size are enjoyed by large producers with both systems (Figures 49 and 50). For the larger producers, benefits from waste outweigh disposal costs while the smaller producers suffer costs of approximately $5 per animal year.

Grass infiltration is an inexpensive pollution control system affecting the large producer and small producer equally. For the unpaved lot with shelter, annual net system costs for runoff control increase only $0.12 per animal year and $0.03 per animal year for the 200 and 5000 head lots, respectively.

TABLE 45. SHEEP, EWES AND LAMBS, UNPAVED LOT WITHOUT SHELTER, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients: 50 Percent Usage of Available Nutrients (4)	Returns to Nutrients: 100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	Net System Returns: At 50 Percent Usage of Nutrients (4)-(6)-(7)	Net System Returns: At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Unpaved lot, no shelter, solid handling	Base	150	1.25	2.50	2.22	7.24	- 8.21	- 6.96	D-7
	Runoff control-detention/ irrigation	150	1.25	2.50	2.22	9.54	-10.51	- 9.26	D-8
	Base	750	1.25	2.50	1.31	1.64	- 1.70	- 0.45	D-9
	Runoff control-detention/ irrigation[b]	750	1.25	2.50	1.31	2.25	- 2.30	- 1.05	D-10

[a] Regions: warm arid and hot arid.

[b] Due to the region location of these systems, the irrigation component is assumed to be in place. Thus, fixed costs of irrigation are not included in the analysis.

TABLE 46. SHEEP, FED LAMBS, PAVED LOT WITH SHELTER, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients		Variable Costs (6)	Fixed Costs (7)	Net System Returns		Appendix Reference
			50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)			At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	
			(Dollars per Animal Year)						
Paved lot, shelter, solid handling	Base	200	1.07	2.14	1.59	5.91	-6.43	-5.36	D-11
	Runoff control-grass infiltration	200	1.07	2.14	1.59	6.35	-6.87	-5.80	D-12
	Base	1000	1.07	2.14	1.13	2.53	-1.59	-1.52	D-13
	Runoff control-grass infiltration	1000	1.07	2.14	1.13	2.66	-1.72	-1.65	D-14
	Base	5000	1.07	2.14	0.47	1.82	-1.22	-0.15	D-15
	Runoff control-detention/irrigation	5000	1.07	2.14	0.51	1.96	-1.40	-0.33	D-16
	Runoff control-grass infiltration	5000	1.07	2.14	0.47	1.91	-1.30	-0.23	D-17

[a] Regions: cool humid, cold humid.

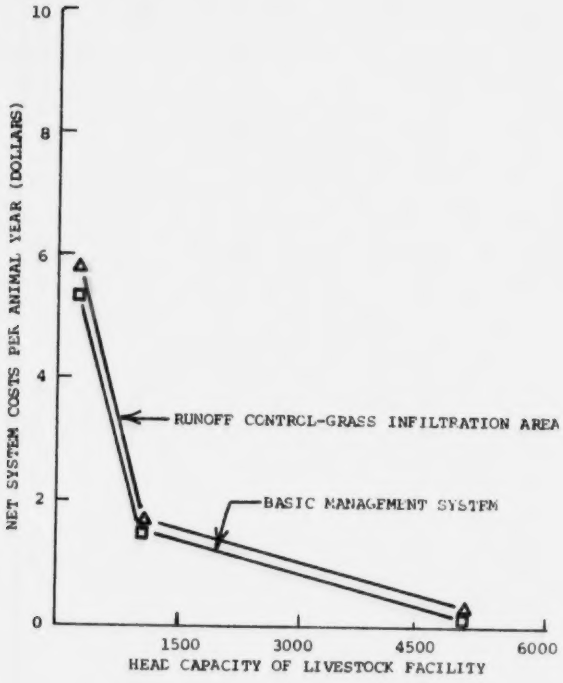

Figure 48. Fed lambs, net system costs for paved lot with shelter (100% utilization of available nutrients assumed).

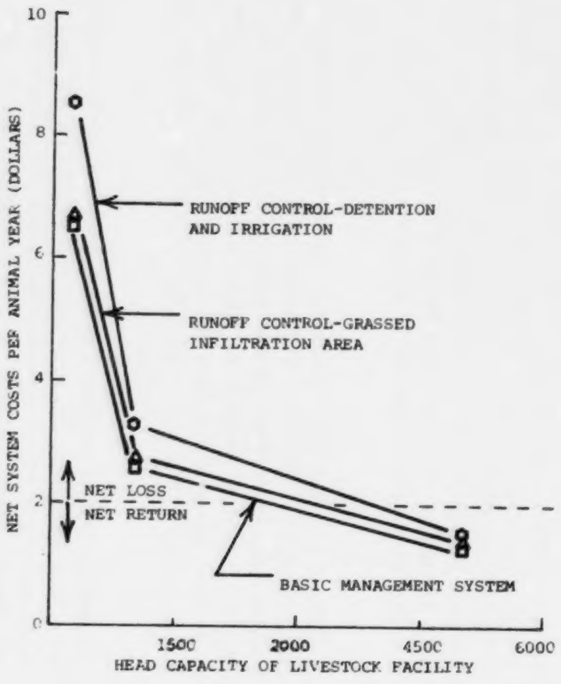

Figure 49. Fed lambs, annual net system costs for unpaved lots with shelter (100% utilization of available nutrients assumed).

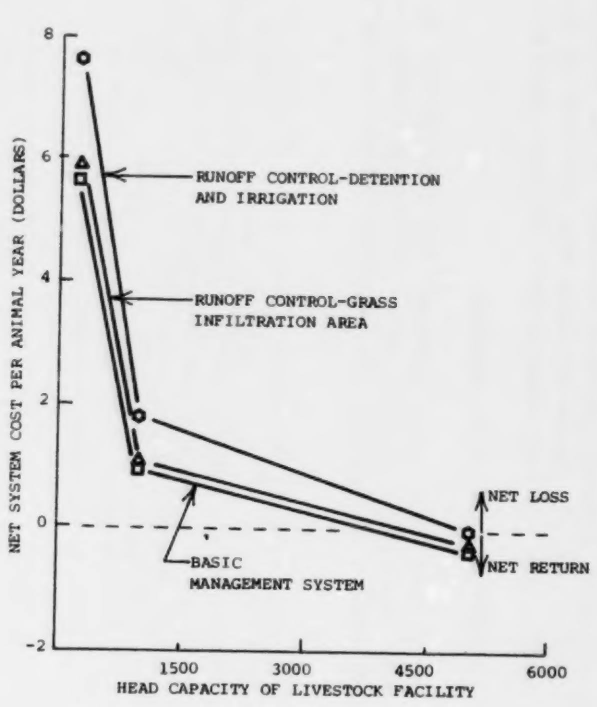

Figure 50. Fed lambs, annual net system costs for unpaved lots without shelter (100% utilization of available nutrients assumed).

On the other hand, detention-irrigation may impose substantial costs on the small producer in regions where irrigation systems are not already in place. On the 200 head capacity unpaved lot with shelter, costs increase by \$2.81 per animal year (\$7.65 - \$4.84, Table 47) with the addition of the detention-irrigation system. For unpaved lots without shelter see Table 48.

LEVEL OF AIR AND WATER POLLUTION FROM SHEEP SYSTEMS

Like the exposed lot systems for other species, the unpaved lot systems for ewe-lamb and fed sheep facilities present water quality problems. Both grass infiltration and detention-irrigation are adequate methods of lessening these problems.

The level of pollution from ewe-lamb systems are shown in Table 49 (systems with shelter) and Table 50 (systems without shelter). Severe pollution (rating of 5) occurs when no runoff control components are present. With the addition of the grass infiltration to the unpaved lot systems found in humid regions, pollution ratings improve to slight pollution (rating of 2). When detention-irrigation is added to the humid regions' shelter systems or the arid regions' open systems, pollution ratings improve to a level of 1 or no pollution, assuming a well managed irrigation system.

Similar evidence of the effectiveness of the detention-irrigation or grass infiltration systems exists for fed lambs as seen in Tables 51, 52, and 53. Generally, the basic management systems produce severe runoff while the runoff control systems improve pollution ratings markedly.

TRADEOFFS BETWEEN SYSTEM COSTS AND POLLUTION CONTROL

For these exposed lot systems, the marginal costs of abating pollution with the grass infiltration system are minute. For ewes and lambs, these added costs are about \$0.20 per animal year on the 150 and 750 head lots (Table 49). For fed lambs these added costs are \$0.13 per animal year on the 1000 head capacity paved lot with shelter (Table 51), and \$0.06 per animal year on the 1000 head capacity unpaved lot with shelter (Table 52), and \$0.09 per animal year on the 1000 head capacity unpaved lot without shelter (Table 53).

The detention-irrigation system has improved water quality when compared to the grass infiltration system. Ratings improve from "2" to "1" as the detention-irrigation system replaces the grass infiltration area in Tables 49, 51, 52 and 53. The cost effectiveness of this marginal improvement remains in doubt, however, For ewes and lambs in humid regions, this improvement costs \$3.83 per animal year (\$11.23 - \$7.40, Table 49) on the 150 head lot.

Undoubtedly, the detention-irrigation system would be recommended in many arid regions. There, the grass infiltration alternative is not feasible. Many feedlots have access to irrigation systems already in place which would help keep runoff control costs down. Costs would increase \$2.02 per animal

TABLE 47. SHEEP, FED LAMBS, UNPAVED LOT WITH SHELTER, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients: 50 Percent Usage of Available Nutrients (4)	Returns to Nutrients: 100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	Net System Returns: At 50 Percent Usage of Nutrients (4)-(6)-(7)	Net System Returns: At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Unpaved lot, with shelter, solid handling	Base	200	1.07	2.14	1.64	5.34	-5.91	-4.84	D-18
	Runoff control-detention/irrigation	200	1.07	2.14	1.89	7.90	-8.72	-7.65	D-19
	Runoff control-grass infiltration	200	1.07	2.14	1.64	5.46	-6.03	-4.96	D-20
	Base	1000	1.07	2.14	1.17	1.96	-2.05	-0.98	D-21
	Runoff control-detention/irrigation	1000	1.07	2.14	1.32	2.63	-2.88	-1.81	D-22
	Runoff control-grass infiltration	1000	1.07	2.14	1.17	2.01	-2.11	-1.04	D-23
	Base	5000	1.07	2.14	0.50	1.25	-0.68	+0.39	D-24
	Runoff control-detention/irrigation	5000	1.07	2.14	0.64	1.47	-1.05	+0.02	D-25
	Runoff control-grass infiltration	5000	1.07	2.14	0.50	1.28	-0.72	+0.35	D-26

[a] Regions: cold arid, cool arid.

TABLE 48. SHEEP, FED LAMBS, UNPAVED LOT WITHOUT SHELTER, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Unpaved lot, no shelter, solid handling	Base	200	0.80	1.60	1.59	4.46	-5.24	-4.44	D-27
	Runoff control-detention/ Irrigation[b]	200	0.80	1.60	1.83	6.23	-7.26	-6.46	D-28
	Runoff control-grass infiltration	200	0.80	1.60	1.59	4.64	-5.43	-4.63	D-29
	Base	1000	0.80	1.60	1.14	1.08	-1.42	-0.62	D-30
	Runoff control-detention/ Irrigation[b]	1000	0.80	1.60	1.30	1.53	-2.03	-1.23	D-31
	Runoff control-grass infiltration	1000	0.80	1.60	1.14	1.16	-1.51	-0.71	D-32
	Base	5000	0.80	1.60	0.48	0.37	-0.05	+0.75	D-33
	Runoff control-detention/ irrigation[b]	5000	0.80	1.60	0.62	0.51	-0.33	+0.47	D-34
	Runoff control-grass infiltration	5000	0.80	1.60	0.48	0.42	-0.11	+0.69	D-35

[a] Regions: warm arid, hot arid, cool arid.

[b] Due to location of these systems, the irrigation component is assumed to be in place. Thus, fixed costs of irrigation are not included in the analysis.

TABLE 49. SHEEP, EWES AND LAMBS, UNPAVED LOT WITH SHELTER, NET SYSTEM RETURNS AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Water		
					Quantity of Runoff	Quality of Runoff	Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Unpaved lot, shelter, solid handling	Base	150	- 9.14	- 7.40	5	5	3
	Runoff control-detention/irrigation	150	-12.97	-11.23	1	1	3
	Runoff control-grass infiltration	150	- 9.34	- 7.60	2	2	3
	Base	750	- 2.64	- 0.90	5	5	3
	Runoff control-detention/irrigation	750	- 4.03	- 2.29	1	1	3
	Runoff control-grass infiltration	750	- 2.74	- 1.10	2	2	3

[a] Scale: 1 No Pollution, 2, 3, 4, 5 Severe Pollution

TABLE 50. SHEEP, EWES AND LAMBS, UNPAVED LOT WITHOUT SHELTER, NET SYSTEM RETURN AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Water		Odor
					Quantity of Runoff	Quality of Runoff	
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Unpaved lot, no shelter, solid handling	Base	150	- 8.21	-6.96	5	5	3
	Runoff control-detention/irrigation	150	-10.51	-9.26	1	1	3
	Base	750	- 1.70	-0.45	5	5	3
	Runoff control-detention/irrigation	750	- 2.30	-1.05	1	1	3

[a] Scale: 1 No Pollution, 2, 3, 4, 5 Severe Pollution

TABLE 51. SHEEP, FED LAMBS, PAVED LOT WITH SHELTER, NET SYSTEM RETURN AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
					Water		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Quantity of Runoff	Quality of Runoff	Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Paved lot, shelter, solid handling	Base	200	-6.43	-5.36	5	5	3
	Runoff control-grass infiltration	200	-6.87	-5.80	2	2	3
	Base	1000	-1.59	-1.52	5	5	3
	Runoff control-grass infiltration	1000	-1.72	-1.65	2	2	3
	Base	5000	-1.22	-0.15	5	5	3
	Runoff control-detention/irrigation	5000	-1.40	-0.33	1	1	3
	Runoff control-grass infiltration	5000	-1.30	-0.23	2	2	3

[a] Scale: 1 No Pollution 2 3 4 5 Severe Pollution

TABLE 52. SHEEP, FED LAMBS, UNPAVED LOT WITH SHELTER, NET SYSTEM RETURNS AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Water		Odor
					Quantity of Runoff	Quality of Runoff	
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Unpaved lot, shelter, solid handling	Base	200	-5.91	-4.84	5	5	3
	Runoff control-detention/irrigation	200	-8.72	-7.65	1	1	3
	Runoff control-grass infiltration	200	-6.03	-4.96	2	2	3
	Base	1000	-2.05	-0.98	5	5	3
	Runoff control-detention/irrigation	1000	-2.88	-1.81	1	1	3
	Runoff control-grass infiltration	1000	-2.11	-1.04	2	2	3
	Base	5000	-0.68	+0.39	5	5	3
	Runoff control-detention/irrigation	5000	-1.05	+0.02	1	1	3
	Runoff control-grass infiltration	5000	-0.72	+0.35	2	2	3

[a] Scale:	1	2	3	4	5
	No Pollution				Severe Pollution

TABLE 53. SHEEP, FED LAMBS, UNPAVED LOT WITHOUT SHELTER, NET SYSTEM RETURNS AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
					Water		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Quantity of Runoff	Quality of Runoff	Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Unpaved lot, no shelter, solid handling	Base	200	-5.24	-4.44	5	5	3
	Runoff control-detention/ irrigation	200	-7.26	-6.46	1	1	3
	Runoff control-grass infiltration	200	-5.43	-4.63	2	2	3
	Base	1000	-1.42	-0.62	5	5	3
	Runoff control-detention/ irrigation	1000	-2.03	-1.23	1	1	3
	Runoff control-grass infiltration	1000	-1.51	-0.71	-0.71	2	2
	Base	5000	-0.05	+0.75	5	5	3
	Runoff control-detention/ irrigation	5000	-0.33	+0.47	1	1	3
	Runoff control-grass infiltration	5000	-0.11	+0.69	2	2	3

[a] Scale: 1 No Pollution 2 3 4 5 Severe Pollution

year on the 200 head lot ($6.46 - $4.44, Table 53), or $0.24 per animal year on the 5000 head lot if detention-irrigation is installed on unpaved feedlots without shelter where the present irrigation system can be used for disposing of the detained water.

SECTION 10

POULTRY WASTE MANAGEMENT OPTIONS

The trend is towards larger facilities for poultry production. Three types of poultry production facilities are considered: layers, broilers and turkeys. With the exception of some turkeys, poultry is raised in totally housed systems. Layers are typically raised in cages. Broilers are almost exclusively raised on litter (bedded floors). Turkeys are raised on litter and on open, vegetated lots.

The principal pollution control needed is for odor. Poultry waste, particularly when stored in a liquid form, generates offensive odors. If poultry manure from layers is partially dried by "under cage" ventilation, the manure can be handled as a solid with less odor nuisance. Provision to collect and drain away water from leaking waterers is necessary. In arid climates under-cage drying is the standard practice (Figure 51). If the manure becomes very dry, blowing manure dust and feathers may be a problem during field spreading. Plowdown immediately after spreading will reduce non-point source runoff of pollutants as well as conserve a substantial amount of nitrogen for crop production.

WASTE SYSTEMS

A typical shallow pit (4 to 6 inches deep) in a caged layer facility is shown in Figure 52. Manure can be scraped on a daily basis but more often it is left to accumulate from two to four weeks and then scraped and field spread. The mechanical scraper shown in Figure 52 is one variation of the shallow pit system. Additional storage can be provided by deepening the pit.

Another common type of manure handling for caged layers is the deep pit or "high-rise" system shown in Figure 53. A distance of 6 or more feet is provided beneath the cages. Manure is allowed to accumulate for a year or longer. All water must be diverted from the pit and under-cage ventilation is needed. As a result of drying and decomposition the volume is reduced. A tractor loader goes beneath the cages and loads the manure for field spreading. Immediate incorporation will lower non-point source pollutant runoff and conserve fertilizer nutrients.

In warm arid regions, a shallow pit, flush system is often used in conjunction with an existing irrigation system. Waste accumulates in a shallow pit where it is flushed into a storage basin and then pumped into an irrigation system. Also, in warm and hot humid regions, a shallow pit flush system is used. There, waste is flushed from a shallow pit beneath the cages to a

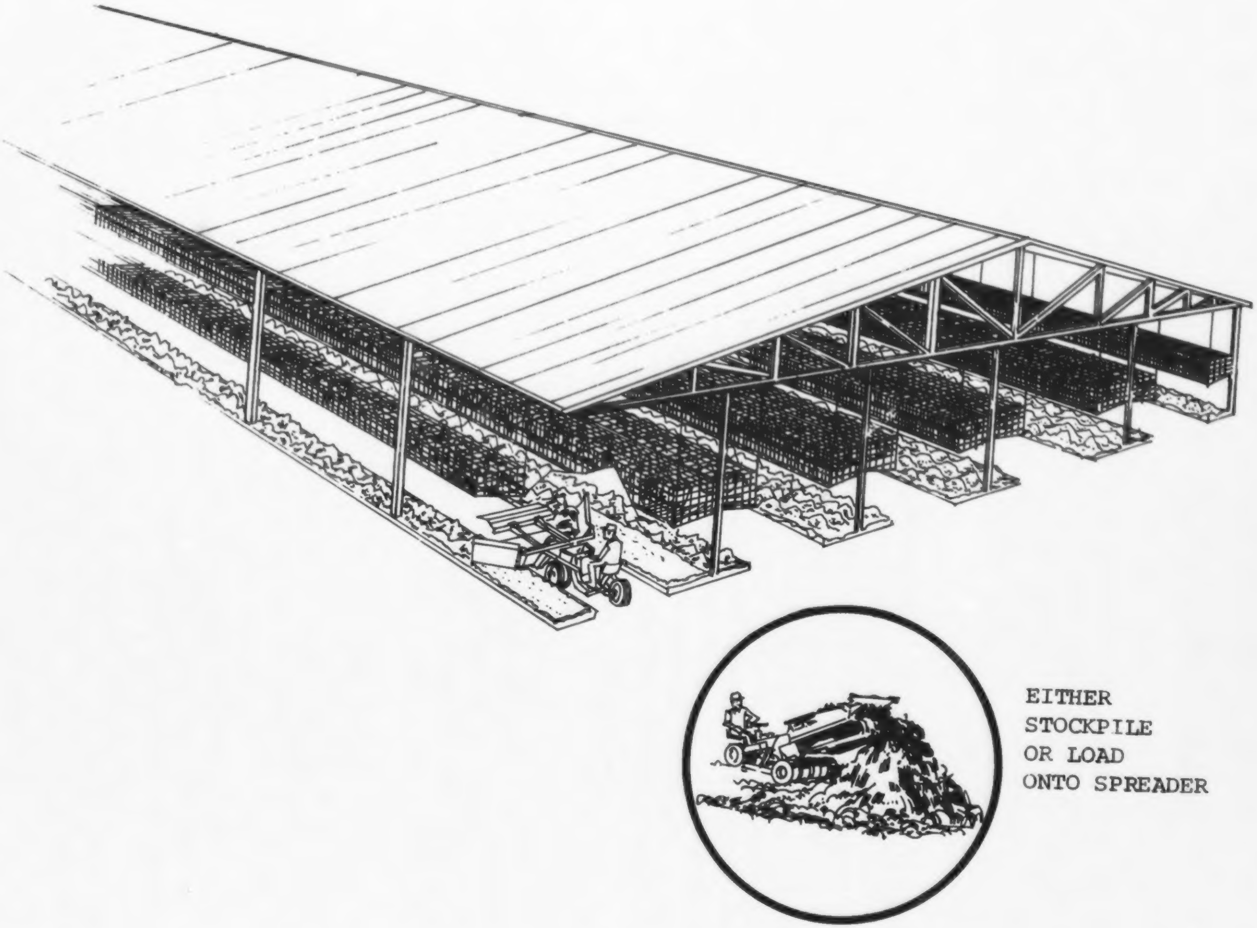
EITHER
STOCKPILE
OR LOAD
ONTO SPREADER

Figure 51. Caged layer facility in arid region, manure handled as a solid in building with open sides.

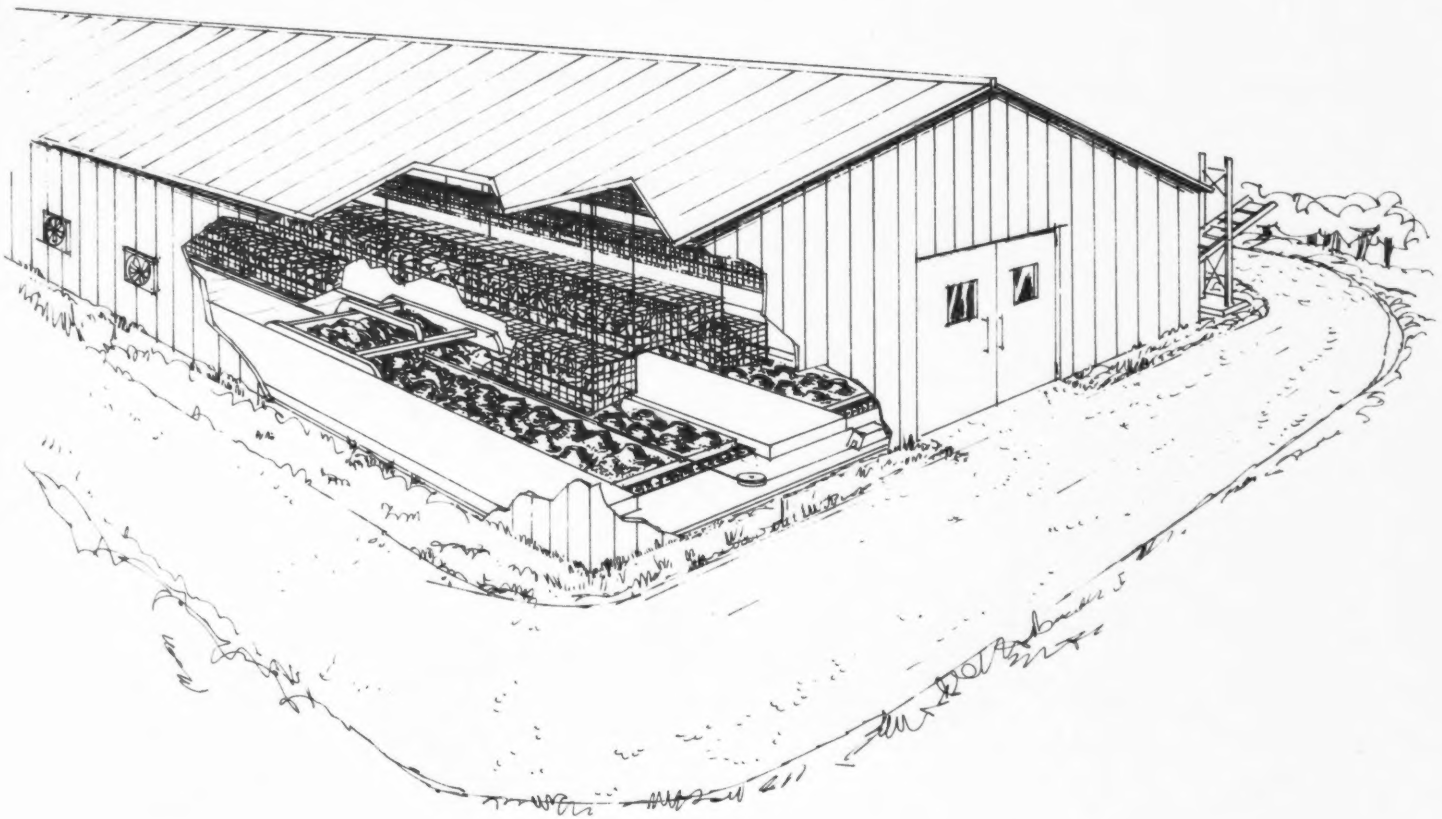

Figure 52. Caged layer house with a mechanical (cable) scraper.

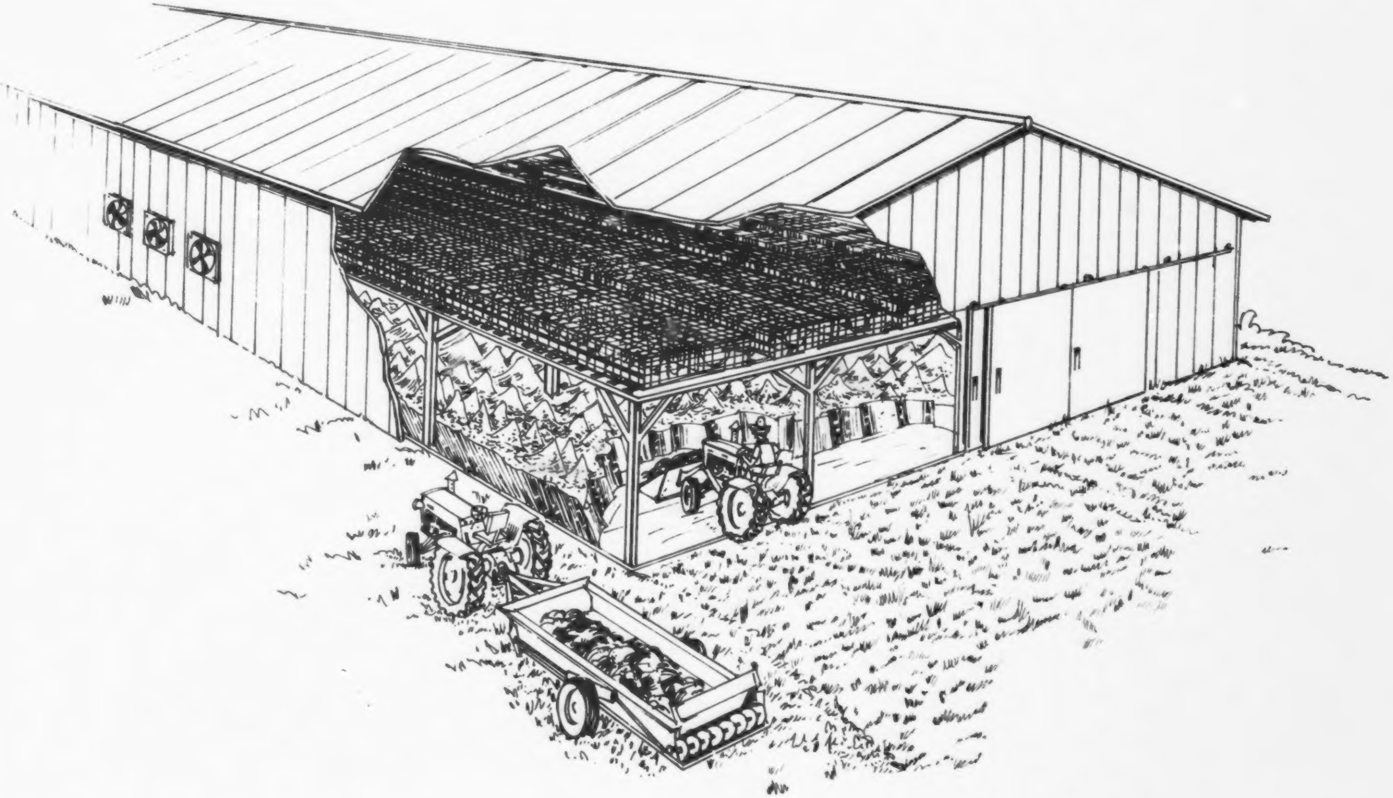

Figure 53. Caged layer "high-rise" house. Manure accumulates for one or more years.

treatment lagoon. Frequently, the wastewater effluent is spread on cropland by an irrigation system.

Figure 54 shows a litter (bedded floor) system. The building on the left shows the typical method for cleaning out the poultry house. Broilers and turkeys, both laying hens and meat birds, are raised on similar litter systems. The usual cleanout procedure is to load the manure into a spreader and haul to cropland. With a planned cleanout interval between flocks of broilers and turkeys, no problems are usually encountered. Some broiler facilities will treat the litter and possibly add some clean bedding between flocks, so that cleanout will only be needed after several flocks, once or twice a year. Immediate soil incorporation of manure into soil will reduce odor and conserve nutrients.

In the humid areas, many turkeys are raised on open, vegetated lots. The vegetated area is soon denuded by the turkeys. By moving waterers and feed troughs to a new area weekly, vegetation will recover on denuded areas. Lot areas have only one group of turkeys per year. Site selection, providing a grassed buffer strip between lots and waterways and reduced stocking rate to maintain some vegetative cover, will reduce non-point source pollutant runoff. Shelter (or shade trees) is needed, particularly in warm and hot climates.

Options to be Analyzed

Concentration into large sized operating units has occurred more rapidly in poultry than in any other livestock species. Two decades ago numerous small flocks could be seen on many farms throughout the United States; however, concentrations of 100,000 layers or broilers in one operation are frequently found today.

As concentration has occurred, pollution control has improved in most cases. Layers and broilers typically are confined in enclosed houses with no outside areas to produce runoff problems. Pollution control centers around the components to store and incorporate the waste.

For poultry the choice of systems is narrowed to those allowing solid handling since the solids content of the waste varies from 25 to 50 percent, depending on the length of storage and in-house drying. Six solid handling systems are analyzed for layers, one system is analyzed for broilers and two for turkeys.

Layers are typically raised in cages. The space requirements used in analyzing costs are 0.42 sq ft of cage floor space per bird and 0.8 sq ft of housing per bird. Where layers are raised on litter approximate costs can be obtained by doubling the waste handling costs of broiler production for a comparative size facility. The sizes of flocks used in the cost evaluation are 10,000, 25,000 and 80,000 birds. Waste systems to be costed include:

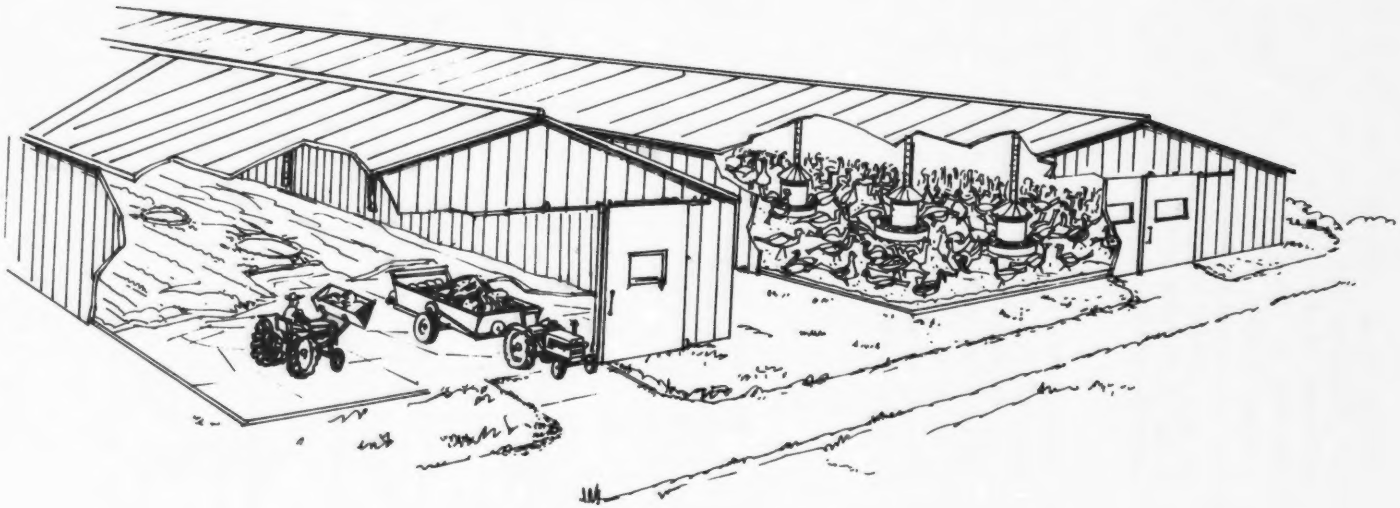

Figure 54. Litter system for broilers or turkeys. Buildings are cleaned between groups of birds.

1. Undercage storage, tractor scrape, solid handling
    (a) base system
    (b) 3 month storage
2. Shallow pit, mechanical scrape, solid handling
3. High-rise building, tractor loader, solid handling
4. Shallow pit, flush to storage basin, pump to irrigation system
5. Shallow pit, flush to lagoon, wastewater disposal

Broilers are typically raised on litter: straw, sawdust, wood shavings, etc. Some broiler houses in warmer regions do not use concrete floors; nevertheless, the cost analysis in this manual assumes concrete floors. A floor area of 0.9 sq ft per broiler is used. The cost of bedding used per bird-year is $0.03. New bedding is costed for each batch of broilers. A turnover rate of 5.0 batches of broilers per year is assumed. A tractor scraper/loader and a solid spread method was used for the waste handling system.

Turkeys are raised with two types of facilities: a litter system similar to broilers and an open lot (pasture) system. When the lot system is used, only one group of turkeys is produced per year. Two groups of turkeys are raised each year on the litter system.

The average floor space for turkeys on a litter system used in the cost analysis is 3.0 sq ft per bird. The cost of bedding used per bird-year is $0.04. A tractor scraper/loader and solid handling method is used in costing this system.

For turkeys on open lot, a density of 750 birds per acre is used for the base system. Densities range from about 250 to 1000 birds per acre in practice. An alternative system to control pollution is to reduce the density to 250 birds per acre and assume that feeders and waterers are moved weekly to a new area in the pasture to allow vegetation to recover.

Chicken and turkey brooding operations typically use a litter system with solid handling. For chicken brooding, 2 sq ft of floor space per bird is assumed in the analysis, and 3 sq ft of floor space per bird is assumed for turkey brooding. Approximately 0.3 cu ft of bedding is used for chicken and 0.5 cu ft for turkey brooding.

ECONOMIC ANALYSIS

Poultry waste management systems tend to be fewer and less variable than other species such as swine or dairy. Thus, the differences in benefits and costs between systems can be expected to be relatively minor. It must be remembered that these small differences in net system cost per bird can be important with the size of today's poultry operations. For example, a difference in net system costs between two systems may be only $0.10 per bird for a layer operation; however, for the 80,000 layer facility this small difference would produce an $8,000 difference in annual profits.

Benefits from Waste

Poultry produce a relatively large amount of nutrients per pound of animal. For example, the 4 pound layer produces a total of 2.5 pounds of nutrients per year (1.06 pounds nitrogen, 0.91 pounds phosphate, and 0.53 pounds potash). Due to the relatively high proportion of ammonia nitrogen, significant nitrogen losses occur for all waste management systems investigated (Table 54).

Available nutrients are assumed to be either 100 percent or 50 percent utilized in the cost analysis. Unit prices of utilized nutrients are $0.16 per pound for nitrogen, $0.18 for phosphate, and $0.10 for potash.

Analysis of Options

Layers, Undercage Storage Tractor Scrape and Undercage Storage Mechanical Scrape--

Annual net waste system costs are shown in Table 55. For the undercage storage, tractor scrape system, nutrient returns outweigh disposal costs, and annual net system returns per bird-year vary from zero for the 10,000 bird flock to $0.13 per bird-year for the 80,000 bird flock. The pollution control option examined is providing more volume in the shallow pit and spreading less often. Annual net system returns per bird are increased approximately $0.01 by providing storage.

Using the shallow pit storage, mechanical scrape system costs more for all size levels,as illustrated in Figure 55. An important assumption producing these results is that the tractor is used on other farm enterprises, thus the poultry enterprise does not bear the full fixed costs, but only pays an hourly charge. On the other hand, the mechanical scraper costs must be fully borne by the poultry enterprise since it has no other use. For the small flock of 10,000 birds, the mechanical scrape system is costly as annual net system costs per bird-year are $0.06 compared to no costs for the tractor scrape system (Table 55).

Layers, High-Rise, Tractor Scrape--

Annual net system costs are lowest with the high-rise storage system. Nutrient returns slightly improve while fixed costs and variable costs are lower for the high-rise system than the shallow pit systems. Annual net system returns are $0.05 for the 10,000 flock and increase to $0.14 for 80,000 layers. Plowing down the spread waste further increases annual net system returns to $0.08 for 10,000 layers and $0.16 for 80,000 layers.

Layers, Flush to Storage Basin or Lagoon--

In warm arid regions, layer waste disposal systems are often designed to complement an existing irrigation system. Waste is flushed from beneath the cages to a storage basin and then pumped to an existing irrigation

TABLE 54. NITROGEN, PHOSPHATE (P_2O_5) AND POTASH (K_2O) AVAILABLE TO CROPS FROM POULTRY WASTE PER BIRD UNIT[a] FOR ALTERNATIVE DISPOSAL SYSTEMS

System	Nutrients Available to Crops per Bird Year[b] (lb/yr)		
	Nitrogen	Phosphate (P_2O_5)	Potash (K_2O)
Layer			
Shallow pit, scrape, solid surface, spread	0.49	0.82	0.48
Shallow pit, scrape, solid, incorporated[c]	0.59	0.86	0.50
Deep pit storage, solid, surface spread	0.52	0.82	0.48
Deep pit storage, solid, incorporated[c]	0.63	0.86	0.50
Broiler			
Litter, solid, surface spread	0.35	0.41	0.30
Litter, solid, incorporated[c]	0.42	0.43	0.31
Turkey			
Litter, solid, surface spread	1.0	1.4	1.4
Litter, solid, incorporated[c]	1.2	1.5	1.4

[a] One bird unit = 4 lb layer, 2 lb (av wt) broiler, 10 lb (av wt) turkey

[b] Production of nutrient per year:

	N (lbs)	P_2O_5 (lbs)	K_2O (lbs)
4 lb layer	1.06	0.91	0.53
2 lb broiler	0.88	0.45	0.33
10 lb turkey	2.5	1.6	1.5

[c] Plowed down the day of spreading.

TABLE 55. LAYERS, SOLID WASTE HANDLING, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients		Variable Costs (6)	Fixed Costs (7)	Net System Returns		Appendix Reference
			50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)			At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	
					(Dollars per Animal Year)				
Undercage storage, tractor scrape[a]	Base	10,000	0.14	0.28	0.04	0.24	-0.13	0.00	E-1
	3 month storage	10,000	0.14	0.28	0.02	0.25	-0.13	+0.01	E-2
	Base	25,000	0.14	0.28	0.03	0.15	-0.04	+0.09	E-3
	3 month storage	25,000	0.14	0.28	0.01	0.17	-0.04	+0.10	E-4
	Base	80,000	0.14	0.28	0.03	0.12	0.00	+0.13	E-5
	3 month storage	80,000	0.14	0.28	0.01	0.14	-0.01	+0.13	E-6
Shallow pit storage, mechanical scrape[a]	Base	10,000	0.14	0.28	0.04	0.30	-0.20	-0.06	E-7
	Base	25,000	0.14	0.28	0.03	0.24	-0.12	+0.01	E-8
	Base	80,000	0.14	0.28	0.03	0.21	-0.10	+0.04	E-9
High-rise, tractor loader[b]	Surface spread	10,000	0.14	0.28	0.02	0.21	-0.09	+0.05	E-10
	Plowdown	10,000	0.15	0.31	0.02	0.21	-0.07	+0.08	E-11
	Surface spread	25,000	0.14	0.28	0.02	0.18	-0.06	+0.08	E-12
	Plowdown	25,000	0.15	0.31	0.02	0.16	-0.03	+0.12	E-13
	Surface spread	80,000	0.14	0.28	0.01	0.14	0.00	+0.14	E-14
	Plowdown	80,000	0.15	0.31	0.02	0.14	+0.01	+0.16	E-15

[a] Regions: cold, cool, warm, and hot humid and warm arid

[b] Regions: warm arid, cool humid, and warm humid

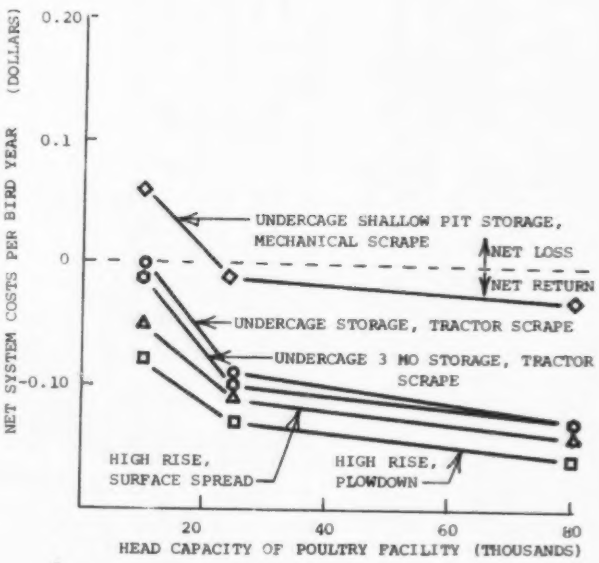

Figure 55. Layers, annual net system costs for solid waste handling alternatives (100% utilization of available nutrients assumed).

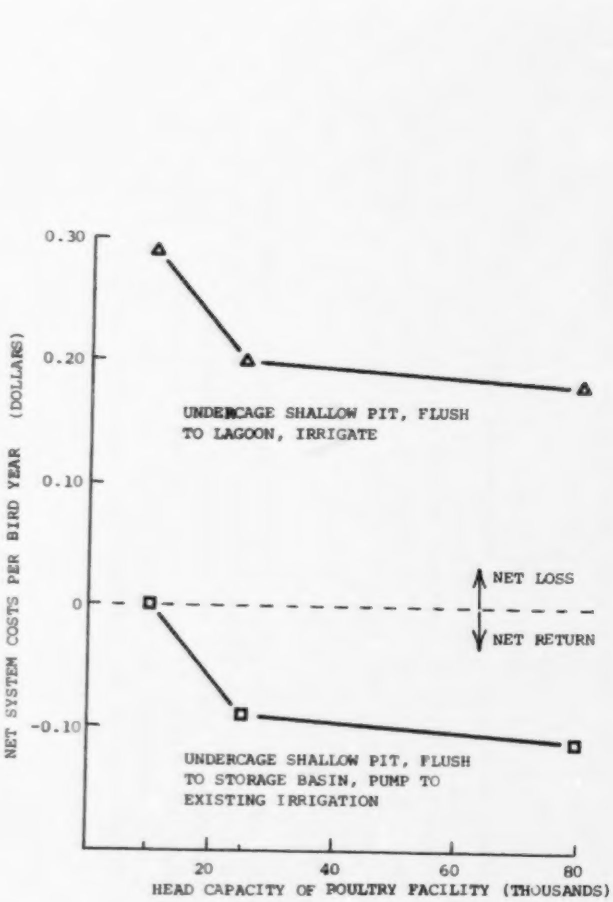

Figure 56. Layers, net system costs for flush systems (100% utilization of available nutrients assumed).

system. Since the irrigation system is a fixed cost to the farmer, its costs are not included in the analysis. Annual net system returns range from zero for the 10,000 bird flock to $0.11 per animal year for the 80,000 bird flock (Table 56).

In warm and hot humid regions, the flush system also uses an irrigation system. However, its primary purpose is for wastewater irrigation; thus, all irrigation costs are included in the analysis. For this shallow pit, flush to lagoon, wastewater irrigation system, annual net system costs range from $0.29 per bird year for the 10,000 bird flock to $0.18 per bird year for the 80,000 bird flock (Table 56). See Figure 56 for a comparison of these two systems.

Broilers on Litter--

Due to its predominance in commercial broiler production, only the litter system is analyzed. For capacities between 25,000 and 80,000 broilers, waste disposal is nearly a break-even proposition (Table 57). The only pollution control technology available for this system is plowdown at the time of spreading. If the cropland is available for plowing, it is a profitable practice for the farmer, plus it reduces odor nuisance and polluted runoff.

Brooders--

The technological options for brooders is limited typically to confinement litter systems. Due to the smaller size relative to broiler and layer operations, per bird costs are higher for chicken brooders. As seen in Table 57, annual net system costs are $0.21 per bird year for the 3000 bird flock.

Nutrient returns are high for the turkey brooder operation, but high space requirements (3 sq ft per bird) result in high fixed costs. Net system costs are $0.29 per bird year for the 3000 bird flock.

Turkey, Confinement and Open Lot--

Annual net system costs are negative for many turkey growers as the returns to the waste outweigh costs of spreading. For the confinement litter system,annual net returns are $0.07 for the 10,000 bird flock and $0.12 for 25,000 turkeys (Table 58). These returns are increased approximately $0.05 per bird when plowdown of spread waste is used.

Open lot turkey waste disposal systems are more costly due to the inability of the farmer to spread the nutrients on cropland and realize a return to waste (Figure 57). Land costs are included for this system. However, operating and fixed costs of waste disposal are negligible. Pollution control becomes a problem with turkeys grown on range as the exposed lot surface may produce severe runoff problems. Although not examined for this alternative, a grass infiltration system would be a low cost method of reducing runoff pollution on open lots.

TABLE 56. LAYERS, SHALLOW PIT WITH FLUSH SYSTEMS, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients		Variable Costs (6)	Fixed Costs (7)	Net System Returns		Appendix Reference
			50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)			At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	
			(Dollars per Animal Year)						
Shallow pit, flush to storage basin, pump to irrigation system[a]	Base	10,000	0.14	0.29	0.04	0.25	-0.14	0.00	E-16
	Base	25,000	0.14	0.29	0.02	0.17	-0.05	+0.09	E-17
	Base	80,000	0.14	0.29	0.03	0.15	-0.03	+0.11	E-18
Shallow pit, flush to lagoon, wastewater irrigation[b]	Base	10,000	0.07	0.14	0.08	0.35	-0.36	-0.29	E-19
	Base	25,000	0.07	0.14	0.08	0.27	-0.27	-0.20	E-20
	Base	80,000	0.07	0.14	0.11	0.21	-0.25	-0.18	E-21

[a] Regions: warm arid

[b] Regions: warm and hot humid

TABLE 57. BROILERS, CHICKEN BROODERS, AND TURKEY BROODERS, LITTER WITH SOLID HANDLING, ANNUAL RETURNS AND COSTS FOR WASTE MANAGEMENT SYSTEMS[a]

Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	Returns to Nutrients: 50 Percent Usage of Available Nutrients (4)	Returns to Nutrients: 100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	Net System Returns: At 50 Percent Usage of Nutrients (4)-(6)-(7)	Net System Returns: At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
			(Dollars per Animal Year)						
Broilers on litter	Base	25,000	0.08	0.16	0.01	0.16	-0.09	-0.01	E-22
	Plowdown	25,000	0.09	0.18	0.01	0.16	-0.09	0.00	E-23
	Base	80,000	0.08	0.16	0.01	0.14	-0.07	+0.01	E-24
	Plowdown	80,000	0.09	0.18	0.01	0.14	-0.06	+0.03	E-25
Chicken Brooders on litter	Base	6,000	0.13	0.26	0.06	0.42	-0.34	-0.21	E-26
	Base	12,000	0.13	0.26	0.06	0.35	-0.27	-0.14	E-27
Turkey Brooders on litter	Base	3,000	0.27	0.53	0.11	0.71	-0.56	-0.29	E-28
	Base	6,000	0.27	0.53	0.11	0.56	-0.40	-0.15	E-29

[a] All humid regions

TABLE 58. TURKEYS, ANNUAL RETURNS AND COSTS FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

			Returns to Nutrients				Net System Returns		
Waste Management System (1)	System Modification (2)	Herd Size (Head Capacity) (3)	50 Percent Usage of Available Nutrients (4)	100 Percent Usage of Available Nutrients (5)	Variable Costs (6)	Fixed Costs (7)	At 50 Percent Usage of Nutrients (4)-(6)-(7)	At 100 Percent Usage of Nutrients (5)-(6)-(7)	Appendix Reference
					(Dollars per Animal Year)				
Confinement, litter, solid handling	Base	10,000	0.27	0.55	0.04	0.45	-0.21	0.07	E-30
	Plowdown	10,000	0.30	0.60	0.04	0.45	-0.18	0.12	E-31
	Base	25,000	0.27	0.55	0.02	0.40	-0.15	0.12	E-32
	Plowdown	25,000	0.30	0.60	0.02	0.40	-0.12	0.17	E-33
Open Lot	Base	10,000	0.00	0.00	0.00	0.18	-0.18	-0.18	E-34
	Reduced density	10,000	0.00	0.00	0.02	0.53	-0.55	-0.55	E-35

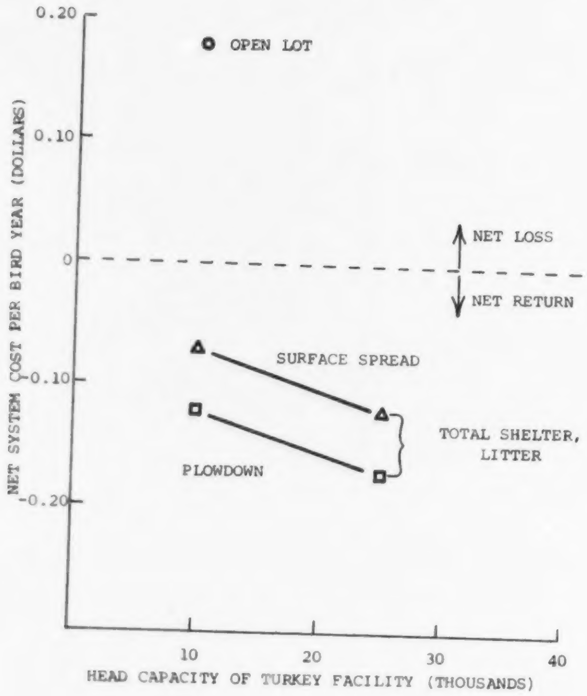

Figure 57. Turkeys, net system costs for waste management systems (100% utilization of available nutrients assumed).

LEVEL OF AIR AND WATER POLLUTION FROM POULTRY SYSTEMS

The movement of layers, broilers, brooders and turkeys into confinement has improved economic efficiency. However, a secondary impact has been the improvement in water quality from these systems. Runoff from facilities is rare since most operations do not have exposed lot surfaces.

Potential water pollution and odor problems exist at the time of spreading. For those poultry systems using solid handling and surface spreading, water pollution receives a moderate rating ("3" in Tables 59, 61, and 62). Runoff of spread waste from fields remains a possible problem in periods of intense rainfall or snow melt. Odor problems at the time of spreading are severe (ratings of "4" or "5" in Tables 59, 61, and 62).

Where storage is used on solid waste handling systems, plowdown of spread waste is an effective method of water pollution and odor control. High-rise systems (Table 59), and litter systems (Tables 61 and 62) receive ratings of no water pollution or odor problems when immediate plowdown is used.

Flush systems for layers are excellent water pollution control systems, as indicated in Table 60. Also, they effectively control odor from the confinement systems and disposal operations if managed properly.

Open lot turkey systems present potential water pollution problems (Table 62). Reduced stocking alleviates some of the water pollution potential, but moderate levels of water pollution remain.

TRADEOFFS BETWEEN SYSTEM COSTS AND POLLUTION CONTROL

Gaining added levels of pollution control is relatively inexpensive on litter systems or facilities using solid handling. Plowdown allows substantial control of pollutants at minimal costs. In most cases plowdown even increases returns to the farmer.

Adoption of systems using flush technologies in climates where appropriate does significantly improve pollution control. However, investing in lagoon, pumps, and irrigation equipment also makes this system more expensive.

Turkey production on open lots appears to be not only uneconomical from the farmer's point of view, but it also has the potential for degrading water quality. Changes from open lot to confinement over the past decade on many turkey farms validate this observation.

TABLE 59. LAYERS, SOLID WASTE HANDLING, ANNUAL NET SYSTEM RETURNS AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return: At 50 Percent Usage of Nutrients	Net System Return: At 100 Percent Usage of Nutrients	Level of Pollution[a]: Water: Quantity of Runoff	Level of Pollution[a]: Water: Quality of Runoff	Level of Pollution[a]: Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Undercage storage, tractor scrape	Base	10,000	-0.13	0.00	3	3	4
	3 month storage	10,000	-0.13	0.01	3	3	5
	Base	25,000	-0.04	0.09	3	3	4
	3 month storage	25,000	-0.04	0.10	3	3	5
	Base	80,000	0.00	0.13	3	3	4
	3 month storage	80,000	0.01	0.13	3	3	5
Shallow pit storage, mechanical scrape	Base	10,000	-0.20	-0.06	3	3	4
	Base	25,000	-0.12	+0.01	3	3	4
	Base	80,000	-0.10	+0.04	3	3	4
High-rise, tractor loader	Surface spread	10,000	-0.09	+0.05	3	3	4
	Plowdown	10,000	-0.07	+0.08	1	1	1
	Surface spread	25,000	-0.06	+0.08	3	3	4
	Plowdown	25,000	-0.03	+0.12	1	1	1
	Surface spread	80,000	-0.01	+0.14	3	3	4
	Plowdown	80,000	+0.01	+0.16	1	1	1

[a] Scale: 1 No Pollution, 2, 3, 4, 5 Severe Pollution

TABLE 60. LAYERS, SHALLOW PIT WITH FLUSH SYSTEMS, ANNUAL NET SYSTEM RETURNS AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
					Water		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Quantity of Runoff	Quality of Runoff	Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Shallow pit, flush to storage basin, pump to irrigation system	Base	10,000	-0.14	0.00	1	1	3
	Base	25,000	-0.05	+0.09	1	1	3
	Base	80,000	-0.03	+0.11	1	1	3
Shallow pit, flush to lagoon, wastewater irrigation	Base	10,000	-0.36	-0.29	1	1	2
	Base	25,000	-0.27	-0.20	1	1	2
	Base	80,000	-0.25	-0.18	1	1	2

[a] Scale: 1 2 3 4 5
No Pollution Severe Pollution

TABLE 61. BROILERS, CHICKEN BROODERS, AND TURKEY BROODERS, LITTER WITH SOLID HANDLING, ANNUAL NET SYSTEM RETURNS AND LEVELS OF POLLUTION

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Water		Odor
					Quantity of Runoff	Quality of Runoff	
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Broilers on litter	Base	25,000	-0.09	-0.01	3	3	4
	Plowdown	25,000	-0.09	0.00	1	1	1
	Base	80,000	-0.07	+0.01	3	3	4
	Plowdown	80,000	-0.06	+0.03	1	1	1
Chicken brooders on litter	Base	6,000	-0.34	-0.21	3	3	4
	Base	12,000	-0.27	-0.14	3	3	4
Turkey brooders on litter	Base	3,000	-0.56	-0.29	3	3	4
	Base	6,000	-0.40	-0.15	3	3	4

[a] Scale: 1 No Pollution, 2, 3, 4, 5 Sever Pollution

TABLE 62. TURKEYS, ANNUAL NET SYSTEM RETURNS AND LEVEL OF POLLUTION FOR ALTERNATIVE WASTE MANAGEMENT SYSTEMS

Waste Management System	System Modification	Herd Size (Head Capacity)	Net System Return		Level of Pollution[a]		
					Water		
			At 50 Percent Usage of Nutrients	At 100 Percent Usage of Nutrients	Quantity of Runoff	Quality of Runoff	Odor
			(Dollars per Animal Year)		(Pollution Scale)[a]		
Confinement, litter, solid handling	Base	10,000	-0.21	0.07	3	3	4
	Plowdown	10,000	-0.18	0.12	1	1	1
	Base	25,000	-0.15	0.12	3	3	4
	Plowdown	25,000	-0.12	0.17	1	1	1
Open lot	Base	10,000	-0.18	-0.18	5	5	3
	Reduced stocking	10,000	-0.55	-0.55	3	3	2

[a] Scale: 1 No Pollution 2 3 4 5 Severe Pollution

SECTION 11

BIBLIOGRAPHY

Ashraf, M., R. L. Christensen, and G. E. Frick. The Impact on Dairy Farm Organization of Alternative Manure Disposal Systems, Research Bulletin 608, Agricultural Experiment Station, University of Massachusetts, 1974.

Bache, D. H., B. C. Horsefield, D. C. Petritz. Costs of Alternative Waste Handling Systems, Department of Agricultural Economics, Purdue University, 1973.

Bielen, R. and B. V. Lessley. Resource Benchmark Data, Waste Handling Practices, and Economic Analysis for Dairy Farms in the Monocay River Watershed, No. 5080, Agricultural Experiment Station, University of Maryland, 1975.

Butchbaker, A. F., J. E. Garton, G.W.A. Mahoney, and M. D. Paine. Evaluation of Beef Cattle Feedlot Waste Management Alternatives, 13040 FXG, Office of Research and Monitoring, Environmental Protection Agency, 1971.

Buxton, B. M. and S. J. Zeigler. Economic Impact of Controlling Surface Water Runoff from U. S. Dairy Farms, Agricultural Economics Report No. 260, Economic Research Service, U.S.D.A., 1974.

Carlisle, B. L. Dairy Waste Management Alternatives, Cooperative Extension Service, North Carolina State University, 1973.

Casler, G. L. and E. L. LaDue. Environmental, Economic and Physical Considerations in Liquid Handling of Dairy Cattle Manure, Bulletin No. 20, Agricultural Experiment Station, Cornell University, 1972.

Coote, D. R., D. A. Haith and P. J. Zeverman. Environmental and Economic Impact of Nutrient Management on the New York Dairy Farm, Search Agriculture, Cornell University, Agricultural Experiment Station, Ithaca, New York, 1975. Vol. 5, No. 5, 28 pp.

Dickey, E. C. and D. H. Vanderholm. Feedlot Runoff Control Systems. In: Proceedings of 1977 Livestock Waste Management Conference. Department of Agricultural Engineering, University of Illinois, Urbana, Illinois, 1977. pp. C1-5.

Driggers, B. Poultry Waste Management Alternatives. Circular 570, Cooperative Extension Service, North Carolina State University, 1973.

Driggers, B. Swine Waste Management Alternatives, Cooperative Extension Service, North Carolina State University, 1973.

Forster, D. L., L. J. Connor, and J. B. Johnson. Economic Impacts of Selected Water Pollution Control Rules on Michigan Beef Feedlots of Less Than 1,000 Head Capacity, Research Report 270, Agricultural Experiment Station, Michigan State University, 1975.

Humenik, F. J. and M. R. Overcash. Design Criteria for Swine Waste Treatment Systems, EPA-600/2-76-233, U.S. Environmental Protection Agency, Ada, Oklahoma, 1976, 292 pp.

Gilbertson, C. B. Animal Waste Utilization on Crop and Pasture Land, (In Press) U. S. Environmental Protection Agency, Ada, Ok., 1977.

Good, D. L., C. R. Hoglund, L. J. Connor, and J. B. Johnson. Economic Impacts of Applying Selected Pollution Control Measures on Michigan Dairy Farms, Research Report 225, Agricultural Experiment Station, Michigan State University, 1973.

Henderson, H. A. and L. L. Bauer. Costs of Manure Disposal on Dairy Farms in Tennessee, Bulletin 514, Agricultural Experiment Station, Tennessee University, 1973.

Hoglund, C. R. Dairy System Analysis Handbook, Rpt. No. 300, Department of Agricultural Economics, Michigan State University, East Lansing, MI, 1976, 49 pp.

Hoglund, C. R., J. S. Boyd, L. J. Connor, and J. B. Johnson. Practices and Systems on Michigan Dairy Farms, Report No. 208, Department of Agricultural Economics, Michigan State University, 1972.

Jedele, D. G., editor. Livestock Waste Management In A Quality Environment, Circular 1074, Cooperative Extension Service, University of Illinois, Urbana, Illinois, 1972.

Jensen, A. H., B. G. Harmon, G. R. Carlisle, and A. J. Muehling. Management and Housing for Confinement Swine Production, Circular 1064, Cooperative Extension Service, University of Illinois, 1974.

Johnson, J. B., G. A. Davis, J. R. Martin, and C. Kerry Gee. Economic Impacts of Controlling Surface Water Runoff from Fed Beef Production Facilities, Agricultural Economic Report No. 292, Economic Research Service, U.S.D.A., 1975.

Kesler, R. P. and A. G. Mueller. Can Confinement Hog Production Facilities be Justified on Illinois Farms? Department of Agricultural Economics, University of Illinois, 1976.

Kesler, R. P. and R. A. Hinton. An Economic Evaluation of Liquid Manure Disposal From Confinement Finishing Hogs, Bulletin 722, Agricultural Experiment Station, University of Illinois, 1966.

Kimball, D., et al. Economic Evaluation of Liquid Manure Storage Systems for Dairy, Bulletin 2199, Agricultural Experiment Station, University of Wisconsin, 1970.

McCaskey, T. A., G. H. Rollins, and J. Little. Water Pollution by Dairy Farm Wastes and Related to Method of Waste Disposal, Water Resources Research Bulletin 18, Auburn University, 1973.

Midwest Plan Service, Beef Housing and Equipment Handbook, MWPS-6, 1968.

Midwest Plan Service, Dairy Housing and Equipment Handbook, NWPS-7, 1971.

Midwest Plan Service, Sheep Housing and Equipment Handbook, MWPS-3, 1974.

Midwest Plan Service, Swine Housing and Equipment Handbook, NWPS-8, 1972.

Midwest Plan Service, Livestock Waste Facilities Handbook, MWPS-18, 1975.

Miner, J. R. and R. J. Smith, editors. Livestock Waste Management with Pollution Control, North Central Regional Research Publication 222, 1975.

Nye, J. C., D. D. Jones, and A. L. Sutton. Runoff Control Systems for Open Livestock Feedlots, Bulletin ID-114, Cooperative Extension Service, Purdue University, West Lafayette, Ind. 8 pp.

Pherson, C. L., P. R. Hasbargen, and T. R. Nodland. Beef Housing Economics for Farm-Feedlots, Economic Report ER77-1, Department of Agricultural and Applied Economics, University of Minnesota, 1977.

Sutton, A. L., J. C. Nye, and D. H. Bache. Options for Managing Waste Within the Building, Swine Housing Management Symposium, Des Moines, Iowa, 1976.

USDA Animal Waste Subcommittee. Implications of EPA Proposed Regulations of November 20, 1975, for the Animal Feeding Industries. U. S. Department of Agriculture, Washington, D.C., 1976, 40 pp.

U. S. Department of Agriculture. Agricultural Waste Management Field Manual. Soil Conservation Service, USDA, 1975.

U. S. Department of Agriculture. Economic Impact of Controlling Surface Water Runoff from Point Sources in U. S. Hog Production. Economic Research Service, Agricultural Economic Report No. 263, 1974, 56 pp.

U. S. Department of Agriculture. Economic Impact of Controlling Surface Water Runoff from Fed-Beef Production Facilities. Economic Research Service, Agricultural Economic Report No. 292, 1975, 39 pp.

U. S. Environmental Protection Agency. Economic Analysis of Proposed Effluent Guidelines, The Feedlots Industry, Small Scale Segments, EPA 230/2-76-008A, Office of Planning and Evaluation, 1977.

Van Arsdall, R. N., R. B. Smith, and T. A. Stucker. Economic Impact of Controlling Surface Water Runoff from Point Sources in U. S. Hog Production Agricultural Economics Report No. 263, Economic Research Service, USDA, 1974.

Watson, H. and R. E. Hermanson. Liquid Manure Handling Systems, Circular R-4 Cooperative Extension Service, Auburn University.

White, R. K. Ohio Livestock Waste Management Guide. Bulletin 604, Cooperative Extension Service, The Ohio State University, Columbus, Ohio.

APPENDIX

The tables in this Appendix give the components for each of the livestock waste systems analyzed. The assumptions for costing these units are given in part in Table 1, p. 28. Unit costs can be determined for each component by dividing the value under "Quantity" into the related value, in subsequent columns. Production and losses of fertilizer nutrients are presented in the respective chapters for each of the species.

The Appendix tables are organized as follows:

Dairy Systems	A-1 through A-59
Beef Systems	B-1 through B-45
Swine Systems	C-1 through C-70
Sheep Systems	D-1 through D-35
Poultry Systems	E-1 through E-35
English to Metric Conversion	Appendix F
Glossary of Terms	Appendix G

TABLE A-1. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, TRACTOR SCRAPE, DAILY SURFACE SPREAD, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	400 hrs		28.00		-28.00
Tractor	400 hrs		39.06		-39.06
Energy	0 kw		0.00		0.00
Trac scraper/loader	1	2,700	10.01		-10.01
Concrete floor	55 ft^2/an	3,710	8.41		- 8.41
Bx spdr/daily use	1	2,150	13.29		-13.29
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		8,560	98.77	48.42	-50.35

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-2. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, TRACTOR SCRAPE, DAILY SURFACE SPREAD, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	688 hrs		24.08		-24.08
Tractor	619 hrs		30.22		-30.22
Energy	0 kw		0.00		0.00
Trac scraper/loader	1	2,700	5.01		- 5.01
Concrete floor	55 ft^2/an	7,420	8.41		- 8.41
Bx spdr/daily use	1	3,800	11.74		-11.74
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		13,920	79.46	48.42	-31.04

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-3. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, TRACTOR SCRAPE, DAILY SURFACE SPREAD, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	1124 hrs		19.67		-19.67
Tractor	1012 hrs		30.82		-30.82
Energy	0 kw		0.00		0.00
Trac scraper/loader	1	4,100	3.80		- 3.80
Concrete floor	50 ft^2/an	13,500	7.65		- 7.65
Bx spdr/no storage	1	4,800	7.42		- 7.42
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		22,400	69.35	48.42	-20.93

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-4. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, TRACTOR SCRAPE, PLANK STORAGE, SURFACE SPREAD, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	400 hrs		28.00		-28.00
Tractor	400 hrs		39.06		-39.06
Energy	0 kw		0.00		0.00
Trac scraper/loader	1	2,700	10.01		-10.01
Concrete floor	55 ft^2/an	3,710	8.41		- 8.41
Storage/plank	4x75x75 ft	5,900	20.66		-20.66
Bx spdr/storage	1	2,150	8.86		- 8.86
Nutrients					
N	143 lb/an yr			22.88	+22.88
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		14,460	115.00	51.46	-63.54

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-5. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, TRACTOR SCRAPE, PLANK STORAGE, SURFACE SPREAD, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	626 hrs		21.91		-21.91
Tractor	563 hrs		27.49		-27.49
Energy	0 kw		0.00		0.00
Trac scraper/loader	1	2,700	5.01		- 5.01
Concrete floor	55 ft^2/an	7,420	8.41		- 8.41
Storage/plank	4x75x150 ft	10,800	18.91		-18.91
Bx spdr/storage	1	3,800	7.83		- 7.83
Nutrients					
N	143 lb/an yr			22.88	+22.88
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		24,720	89.55	51.46	-38.09

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-6. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, TRACTOR SCRAPE, PLANK STORAGE, SURFACE SPREAD, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	995 hrs		17.41		-17.41
Tractor	896 hrs		27.28		-27.28
Energy	0 kw		0.00		0.00
Trac scraper/loader	1	4,100	3.80		- 3.80
Concrete floor	50 ft^2/an	13,500	7.65		- 7.65
Storage/plank	4x100x225 ft	18,000	15.76		-15.76
Bx spdr/storage	1	4,800	4.94		- 4.94
Nutrients					
N	143 lb/an yr			22.88	+22.88
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		40,400	76.85	51.46	-25.39

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-7. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL TRACTOR SCRAPE, PIT STORAGE, SURFACE SPREAD, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	407 hrs		28.49		-28.49
Tractor	366 hrs		40.74		-40.74
Energy	0 kw		0.00		0.00
Concrete floor	55 ft^2/an	3,710	8.42		- 8.42
Trac scraper/cattle	1	700	2.60		- 2.60
Agitate/load pump	1	3,200	19.12		-19.12
Concrete pit		10,400	23.57		-23.57
Tank Wagon	1	4,100	19.67		-19.67
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		22,110	142.59	47.14	-95.45

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-8. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, TRACTOR SCRAPE, PIT STORAGE, PLOWDOWN, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	407 hrs		28.49		-28.49
Tractor	366 hrs		40.74		-40.74
Energy	0 kw		0.00		0.00
Concrete floor	55 ft^3/an	3,710	8.42		- 8.42
Trac scraper/cattle	1	700	2.60		- 2.60
Agitate/load pump	1	3,200	19.12		-19.12
Concrete pit	22,500 ft^3	10,400	23.57		-23.57
Tank wagon	1	4,100	19.67		-19.67
Nutrients					
N	149 lb/an yr			23.84	+23.84
P_2O_5	80 lb/an yr			14.40	+14.40
K_2O	158 lb/an yr			15.80	+15.80
Total		22,110	142.59	54.04	-88.55

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-9. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, TRACTOR SCRAPE, PIT STORAGE, SURFACE SPREAD, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	626 hrs		21.91		-21.91
Tractor	563 hrs		41.97		-41.97
Energy	0 kw		0.00		0.00
Concrete floor	55 ft^2/an	7,420.00	8.41		- 8.41
Trac scraper/cattle	1	700.00	1.44		- 1.44
Agitate/load pump	1	3,200.00	9.89		- 9.89
Concrete pit	45,000 ft^3	20,800.00	23.57		-23.57
Tank wagon	1	5,400.00	12.95		-12.95
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		37,520.00	120.14	47.14	-73.00

[a]Regions: cool humid, cold humid, warm humid.

TABLE A-10. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, TRACTOR SCRAPE, PIT STORAGE, PLOWDOWN, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	626 hrs		21.91		-21.91
Tractor	563 hrs		41.97		-41.97
Energy	0 kw		0.00		0.00
Concrete floor	55 ft^2/an	7,420.00	8.41		- 8.41
Trac scraper/cattle	1	700.00	1.44		- 1.44
Agitate load pump	1	3,200.00	9.89		- 9.89
Concrete pit	45,000 ft^3	20,800.00	23.57		-23.57
Tank wagon	1	5,400.00	12.95		-12.95
Nutrients					
N	149 lb/an yr			23.84	+23.84
P_2O_5	80 lb/an yr			14.40	+14.40
K_2O	158 lb/an yr			15.90	+15.80
Total		37,520.00	120.14	54.04	-66.10

[a]Regions: cool humid, cold humid, warm humid.

TABLE A-11. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, TRACTOR SCRAPE, PIT STORAGE, SURFACE SPREAD, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	939 hrs		16.43		-16.43
Tractor	809 hrs		30.16		-30.16
Energy	0 kw		0.00		0.00
Concrete floor	55 ft^2/an	14,840	8.41		- 8.41
Trac scraper/cattle	1	700	0.72		- 0.72
Agitate/load pump	1	3,200	4.94		- 4.94
Concrete pit	90,000 ft^3	41,600	23.57		-23.57
Tank wagon	1	5,400	6.48		- 6.48
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		65,740	90.70	47.14	-43.56

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-12. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, TRACTOR SCRAPE, PIT STORAGE, PLOWDOWN, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	939 hrs		16.43		-16.43
Tractor	809 hrs		30.16		-30.16
Energy	0 kw		0.00		0.00
Concrete floor	55 ft^2/an	14,840	8.41		- 8.41
Trac scraper/cattle	1	700	0.72		- 0.72
Agitate/load pump	1	3,200	4.94		- 4.94
Concrete pit	90,000 ft^3	41,600	23.57		-23.57
Tank wagon	1	5,400	6.48		- 6.48
Nutrients					
N	149 lb/an yr			23.84	+23.84
P_2O_5	80 lb/an yr			14.40	+14.40
K_2O	158 lb/an yr			15.80	+15.80
Total		65,740	90.70	54.04	-36.66

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-13. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, SLOTTED FLOOR, PIT STORAGE, SURFACE SPREAD, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	396 hrs		13.86		-13.86
Tractor	355 hrs		26.47		-26.47
Energy	5,000 kw		2.77		- 2.77
Agitate/load pump	1	3,200	9.89		- 9.89
Concrete slats	1,450 ft^2	3,200	5.27		- 5.27
Concrete pit	33,000 ft^3	47,200	53.48		-53.48
Pit ventilation	1	550	1.70		- 1.70
Tank wagon	1	5,400	12.95		-12.95
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		59,550	126.40	47.14	-79.26

[a] Region: cool humid, cold humid, warm humid.

TABLE A-14. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, SLOTTED FLOOR, PIT STORAGE, PLOWDOWN, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	396 hrs		13.86		-13.86
Tractor	355 hrs		26.47		-26.47
Energy	5,000 kw		2.77		- 2.77
Agitate/load pump	1	3,200	9.89		- 9.89
Concrete slats	1,450 ft^2	3,200	5.27		- 5.27
Concrete pit	33,000 ft^3	47,200	53.48		-53.48
Pit ventilation	1	550	1.70		- 1.70
Tank wagon	1	5,400	12.95		-12.95
Nutrients					
N	149 lb/an yr			23.84	+23.84
P_2O_5	80 lb/an yr			14.40	+14.40
K_2O	158 lb/an yr			15.80	+15.80
Total		59,550	126.40	54.04	-72.36

[a] Region: cool humid, cold humid, warm humid.

TABLE A-15. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, MECHANICAL SCRAPE, PISTON PUMP, EARTHEN STORAGE, SURFACE SPREAD, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	268 hrs		18.76		-18.76
Tractor	288 hrs		49.90		-49.90
Energy	300 kw		0.33		- 0.33
Alleyway scraper	1	4,470	22.37		-22.37
Piston pump/hollow	1	3,000	14.39		-14.39
Agitate/load pump	1	3,200	19.78		-19.78
Storage basin	37,000 ft^3	5,100	12.61		-12.61
Concrete floor	55 ft^2/an	3,710	8.41		- 8.41
Tank wagon	1	4,100	19.67		-19.67
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		23,580	166.20	47.14	-119.06

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-16. ECONOMIC DATA FOR DAIRY CONFINED FREE STALL, MECHANICAL SCRAPE, PISTON PUMP, EARTHEN STORAGE, PLOWDOWN, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	268 hrs		18.76		-18.76
Tractor	288 hrs		49.90		-49.90
Energy	300 kw		0.33		- 0.33
Alleyway scraper	1	4,470	22.36		-22.36
Piston pump/hollow	1	3,000	14.39		-14.39
Agitate/load pump	1	3,200	19.78		-19.78
Storage basin	37,000 ft^3	5,100	12.61		-12.61
Concrete floor	55 ft^2/an	3,710	8.41		- 8.41
Tank wagon	1	4,100	19.67		-19.67
Nutrients					
N	149 lb/an yr			23.84	+23.84
P_2O_5	80 lb/an yr			14.40	+14.40
K_2O	158 lb/an yr			15.80	+15.80
Total		23,580	166.19	54.04	-112.15

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-17. ECONOMIC DATA FOR DAIRY CONFINED FREE STALL, MECHANICAL SCRAPE, PISTON PUMP, EARTHEN STORAGE, SURFACE SPREAD, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	408 hrs		14.28		-14.28
Tractor	445 hrs		38.55		-38.55
Energy	600 kw		0.33		- 0.33
Alleyway scraper	1	4,970	11.92		-11.92
Piston pump/hollow	1	3,800	8.37		- 8.37
Agitate/load pump	1	3,200	9.89		- 9.89
Storage basin	73,000 ft^3	9,100	8.36		- 8.36
Concrete floor	55 ft^2/an	7,420	6.11		- 6.11
Tank wagon	1	5,400	11.75		-11.75
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		33,890	109.56	47.14	-62.42

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-18. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, MECHANICAL SCRAPE, PISTON PUMP, EARTHEN STORAGE, PLOWDOWN, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	408 hrs		14.28		-14.28
Tractor	445 hrs		38.55		-38.55
Energy	600 kw		0.33		- 0.33
Alleyway scraper	1	4,970	11.92		-11.92
Piston pump/hollow	1	3,800	8.37		- 8.37
Agitate/load pump	1	3,200	9.89		- 9.89
Storage basin	73,000 ft^3	9,100	8.36		- 8.36
Concrete floor	55 ft^2/an	7,420	6.11		- 6.11
Tank wagon	1	5,400	11.75		-11.75
Nutrients					
N	149 lb/an yr			23.84	+23.84
P_2O_5	80 lb/an yr			14.40	+14.40
K_2O	158 lb/an yr			15.80	+15.80
Total		33,890	109.56	54.04	-55.52

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-19. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, MECHANICAL SCRAPE, PISTON PUMP, EARTHEN STORAGE, SURFACE SPREAD, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	650 hrs		11.38		-11.38
Tractor	740 hrs		27.58		-27.58
Energy	900 kw		0.25		- 0.25
Alleyway scraper	1	6,050	7.57		- 7.57
Piston pump/hollow	1	3,800	4.56		- 4.56
Agitate/load pump	1	3,200	4.94		- 4.94
Storage basin	146,000 ft^3	16,600	10.26		-10.26
Concrete floor	55 ft^2/an	14,840	8.41		- 8.41
Tank wagon	1	7,000	8.39		- 8.39
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		51,490	83.34	47.14	-36.20

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-20. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, MECHANICAL SCRAPE, PISTON PUMP, EARTHEN STORAGE, PLOWDOWN, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	650 hrs		11.38		-11.38
Tractor	740 hrs		27.58		-27.58
Energy	900 kw		0.25		- 0.25
Alleyway scraper	1	6,050	7.57		- 7.57
Piston pump/hollow	1	3,800	4.56		- 4.56
Agitate/load pump	1	3,200	4.94		- 4.94
Storage basin	146,000 ft^3	16,600	10.26		-10.26
Concrete floor	55 ft^2/an	14,480	8.27		- 8.27
Tank wagon	1	7,000	8.39		- 8.39
Nutrients					
N	149 lb/an yr			23.84	+23.84
P_2O_5	80 lb/an yr			14.40	+14.40
K_2O	158 lb/an yr			15.80	+15.80
Total		51,130	83.21	54.04	-29.17

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-21. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, MECHANICAL SCRAPE, PISTON PUMP, SILO STORAGE, SURFACE SPREAD, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	408 hrs		14.28		-14.28
Tractor	345 hrs		25.72		-25.72
Energy	600 kw		0.33		- 0.33
Alleyway scraper	1	4,970	12.43		-12.43
Piston pump/hollow	1	3,800	9.11		- 9.11
Agitate/load pump	1	3,200	9.89		- 9.89
Above ground tank	18,000 ft^3	16,500	18.69		-18.69
Concrete floor	55 ft^2/an	7,420	8.41		- 8.41
Tank wagon	1	5,400	12.95		-12.95
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		41,290	111.82	47.14	-64.68

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-22. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, MECHANICAL SCRAPE, PISTON PUMP, SILO STORAGE, PLOWDOWN, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	408 hrs		14.28		-14.28
Tractor	345 hrs		25.72		-25.72
Energy	600 kw		0.33		- 0.33
Alleyway scraper	1	4,970	12.43		-12.43
Piston pump/hollow	1	3,800	9.11		- 9.11
Agitate/load pump	1	3,200	9.89		- 9.89
Above ground tank	18,000 ft^3	16,500	18.69		-18.69
Concrete floor	55 ft^2/an	7,420	8.41		- 8.41
Tank wagon	1	5,400	12.95		-12.95
Nutrients					
N	149 lb/an yr			23.84	+23.84
P_2O_5	80 lb/an yr			14.40	+14.40
K_2O	158 lb/an yr			15.80	+15.80
Total		41,290	111.82	54.04	-57.78

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-23. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, MECHANICAL SCRAPE, PIT STORAGE, SURFACE SPREAD, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	408 hrs		14.28		-14.28
Tractor	345 hrs		25.72		-25.72
Energy	32,000 kw		17.76		-17.76
Alleyway scraper	1	4,970	12.43		-12.43
Concrete floor	55 ft^2/an	7,420	8.41		- 8.41
Agitate/load pump	1	3,200	9.89		- 9.89
Concrete pit	33,000 ft^3	47,200	53.48		-53.48
Pit ventilation	1	550	1.70		- 1.70
Tank wagon	1	5,400	12.95		-12.95
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		68,740	156.62	47.14	-109.48

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-24. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, MECHANICAL SCRAPE, PIT STORAGE, PLOWDOWN, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	408 hrs		14.28		-14.28
Tractor	345 hrs		25.72		-25.72
Energy	32,000 kw		17.76		-17.76
Alleyway scraper	1	4,970	12.43		-12.43
Concrete floor	55 ft^2/an	7,420	8.41		- 8.41
Agitate/load pump	1	3,200	9.89		- 9.89
Concrete pit	33,000 ft^3	47,200	53.48		-53.48
Pit ventilation	1	550	1.70		- 1.70
Tank wagon	1	5,400	12.95		-12.95
Nutrients					
N	149 lb/an yr			23.84	+23.84
P_2O_5	80 lb/an yr			14.40	+14.40
K_2O	158 lb/an yr			15.80	+15.80
Total		68,740	156.62	54.04	-102.58

[a] Regions: cool humid, cold humid, warm humid.

TABLE A-25. ECONOMIC DATA FOR DAIRY, CONFINEMENT STALL, GUTTER CLEANER, DAILY SPREAD, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	275 hrs		19.25		-19.25
Tractor	248 hrs		27.60		-27.60
Energy	240 kw		0.27		- 0.27
Concret floor/gutter	1	5,625	12.75		-12.75
Gutter cleaner	1	3,520	14.50		-14.50
Box spdr/daily use	1	2,150	13.29		-13.29
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		11,295	87.65	48.42	-39.23

[a] Regions: cool humid, cold humid.

TABLE A-26. ECONOMIC DATA FOR DAIRY, CONFINEMENT STALL, GUTTER CLEANER, DAILY SPREAD, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	477 hrs		16.69		-16.69
Tractor	365 hrs		29.13		-29.13
Energy	410 kw		0.23		- 0.23
Concret floor/gutter	1	11,250	12.75		-12.75
Gutter cleaner	1	5,500	11.33		-11.33
Box spdr/daily use	1	3,800	11.74		-11.74
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		20,550	81.87	48.42	-33.45

[a] Regions: cool humid, cold humid.

TABLE A-27. ECONOMIC DATA FOR DAIRY, CONFINEMENT STALL, GUTTER CLEANER, PISTON PUMP, CONCRETE STORAGE, SURFACE SPREAD, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	228 hrs		15.96		-15.96
Tractor	207 hrs		23.04		-23.04
Energy	1180 kw		1.31		- 1.31
Concret floor/gutter	1	5,625	12.75		-12.75
Gutter cleaner	1	3,520	14.50		-14.50
Covered concret stor	18,000 ft^3	12,400	28.10		-28.10
Piston pump/solid hd	1	9,600	38.40		-38.40
Bx spdr/periodic use	1	2,150	8.86		- 8.86
Nutrients					
N	143 lb/an yr			22.88	+22.88
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	141 lb/an yr			14.10	+14.10
Total		27,155	142.92	50.66	-92.26

[a] Regions: cool humid, cold humid.

TABLE A-28. ECONOMIC DATA FOR DAIRY, CONFINEMENT STALL, GUTTER CLEANER, PISTON PUMP, CONCRETE STORAGE, PLOWDOWN, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	228 hrs		15.96		-15.96
Tractor	207 hrs		23.04		-23.04
Energy	1180 kw		1.31		- 1.31
Concret floor/gutter	1	5,625	12.75		-12.75
Gutter cleaner	1	3,520	14.50		-14.50
Piston pump/solid hd	1	9,600	38.40		-38.40
Covered concret/stor	18,000 ft^3	12,400	28.10		-28.10
Bx spdr/periodic use	1	2,150	8.86		- 8.86
Nutrients					
N	179 lb/an yr			28.64	+28.64
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		27,155	142.92	57.22	-85.70

[a] Regions: cool humid, cold humid.

TABLE A-29. ECONOMIC DATA FOR DAIRY, CONFINEMENT STALL, SOLID HANDLING, GUTTER CLEANER, PISTON PUMP, CONCRETE STORAGE, SURFACE SPREADING, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	329 hrs		11.51		-11.51
Tractor	105 hrs		6.95		- 6.95
Energy	1760 kw		0.98		- 0.98
Gutter cleaner	1	5,500	11.33		-11.33
Piston pump/solid hd	1	9,600	19.20		-19.20
Covered concret stor	36,000 ft^3	22,500	25.49		-25.49
Concret floor/gutter	1	11,250	12.75		-12.75
Bx spdr/periodic use	1	3,800	7.83		- 7.83
Nutrients					
N	143 lb/an yr			22.88	+22.88
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	141 lb/an yr			14.10	+14.10
Total		52,650	96.04	50.66	-45.38

[a] Regions: cool humid, cold humid.

TABLE A-30. ECONOMIC DATA FOR DAIRY, CONFINEMENT STALL, GUTTER CLEANER, PISTON PUMP, CONCRETE STORAGE, PLOWDOWN, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	329 hrs		11.51		-11.51
Tractor	105 hrs		6.95		- 6.95
Energy	1760 kw		0.98		- 0.98
Gutter cleaner	1	5,500	11.33		-11.33
Piston pump/solid hd	1	9,600	19.20		-19.20
Covered concret stor	36,000 ft^3	22,500	25.49		-25.49
Concret floor/gutter	1	11,250	12.75		-12.75
Bx spdr/periodic use	1	3,800	7.83		- 7.83
Nutrients					
N	179 lb/an yr			28.64	+28.64
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		52,650	96.04	57.22	-38.82

[a] Regions: cool humid, cold humid.

TABLE A-31. ECONOMIC DATA FOR DAIRY, CONFINEMENT STALL, GUTTER CLEANER, STACKER, PLANK STORAGE, SURFACE SPREAD, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	228 hrs		15.96		-15.96
Tractor	207 hrs		23.04		-23.04
Energy	480 kw		0.53		- 0.53
Concret floor/gutter	1	5,625	12.75		-12.75
Gutter cleaner	1	3,520	14.50		-14.50
Stacker	1	3,460	14.26		-14.26
Storage/plank	4x75x75 ft	6,920	24.23		-24.23
Bx spdr/periodic use	1	2,150	8.86		- 8.86
Nutrients					
N	143 lb/an yr			22.88	+22.88
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	141 lb/an yr			14.90	+14.90
Total		21,675	114.13	51.46	-62.67

[a] Regions: cool humid, cold humid.

TABLE A-32. ECONOMIC DATA FOR DAIRY, CONFINEMENT STALL, GUTTER CLEANER, STACKER, PLANK STORAGE, PLOWDOWN, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	228 hrs		15.96		-15.96
Tractor	207 hrs		23.04		-23.04
Energy	480 kw		0.53		- 0.53
Concret floor/gutter	1	5,625	12.75		-12.75
Gutter cleaner	1	3,520	14.50		-14.50
Stacker	1	3,460	14.26		-14.26
Storage/plank	4x75x75 ft	6,920	24.23		-24.23
Bx spdr/periodic use	1	2,150	8.86		- 8.86
Nutrients					
N	170 lb/an yr			27.20	+27.20
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	141 lb/an yr			14.10	+14.10
Total		21,675	114.13	54.98	-59.15

[a] Regions: cool humid, cold humid.

TABLE A-33. ECONOMIC DATA FOR DAIRY, CONFINEMENT STALL, GUTTER CLEANER, STACKER, PLANK STORAGE, SURFACE SPREAD, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	417 hrs		14.59		-14.59
Tractor	378 hrs		21.04		-21.04
Energy	1200 kw		0.67		- 0.67
Concrete floor/gutter	1	11,250	12.75		-12.75
Gutter cleaner	1	5,500	11.33		-11.33
Stacker	1	4,640	9.56		- 9.56
Storage/plank	1	10,800	18.91		-18.91
Bx spdr/periodic use	1	4,600	9.48		- 9.48
Nutrients					
N	143 lb/an yr			22.88	+22.88
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	141 lb/an yr			14.10	+14/10
Total		36,790	98.32	50.66	-47.66

[a] Regions: cool humid, cold humid.

TABLE A-34. ECONOMIC DATA FOR DAIRY, CONFINEMENT STALL, GUTTER CLEANER, STACKER, PLANK STORAGE, PLOWDOWN, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	417 hrs		14.59		-14.59
Tractor	378 hrs		21.04		-21.04
Energy	1200 kw		0.67		- 0.67
Concrete floor/gutter	1	11,250	12.75		-12.75
Gutter cleaner	1	5,500	11.33		-11.33
Stacker	1	4,640	9.56		- 9.56
Storage/plank	1	10,800	18.91		-18.91
Bx spdr/periodic use	1	4,600	9.48		- 9.48
Nutrients					
N	170 lb/an yr			27.20	+27.20
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	141 lb/an yr			14.10	+14.10
Total		36,790	98.32	54.98	-43.34

[a] Regions: cool humid, cold humid.

TABLE A-35. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, DAILY SURFACE SPREAD, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	314 hrs		21.98		-21.98
Tractor	314 hrs		26.38		-26.38
Energy	0 kw		0.00		0.00
Trac scraper/loader	1	2,700	10.01		-10.01
Concrete lot	85 ft^2/an	4,050	9.18		- 9.18
Bx spdr/daily use	1	2,150	13.29		-13.29
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		8,900	80.83	48.42	-32.41

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-36. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, DAILY SURFACE SPREAD, DIVERSION, SETTLING BASIN, GRASS INFILTRATION AREA, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	318 hrs		22.26		-22.26
Tractor	316 hrs		26.54		-26.54
Energy	0 kw		0.00		0.00
Trac scraper/loader	1	2,700	10.01		-10.01
Concrete lot	85 ft^2/an	4,050	9.18		- 9.18
Bx spdr/daily use	1	2,150	13.29		-13.29
Diversion Terrace	200 ft	50	0.17		- 0.17
Settlg basin/concret	200 ft^2	270	1.06		- 1.06
Infiltration area	10x120 ft	96	0.23		- 0.23
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		9,330	82.73	48.42	-34.31

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-37. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, DAILY SURFACE SPREAD, DIVERSION, SETTLING BASIN, DETENTION BASIN, WASTE WATER IRRIGATION, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	332 hrs		23.24		-23.24
Tractor	315 hrs		26.46		-26.46
Energy	400 kw		0.44		- 0.44
Trac scraper/loader	1	2,700	10.01		-10.01
Concrete lot	85 ft^2/an	4,050	9.18		- 9.18
Bx spdr/daily use	1	2,150	13.29		-13.29
Diversion Terrace	200 ft	50	0.17		- 0.17
Settlg basin/earth	200 ft^2	270	1.06		- 1.06
Detention basin	5400 ft^3	325	1.18		- 1.18
Wastewater irrig/RO	1	1,475	9.36		- 9.36
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		11,020	94.38	48.42	-45.96

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-38. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, DAILY SURFACE SPREAD, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	507 hrs		17.74		-17.74
Tractor	507 hrs		24.75		-24.75
Energy	0 kw		0.00		0.00
Trac scraper/loader	1	2,700	5.01		- 5.01
Concrete lot	85 ft^2/an	8,100	9.18		- 9.18
Bx spdr/daily use	1	3,800	11.74		-11.74
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		14,600	68.42	48.42	-20.00

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-39. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, DAILY SURFACE SPREAD, DIVERSION, SETTLING BASIN, GRASS INFILTRATION AREA, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	512 hrs		17.92		-17.92
Tractor	510 hrs		24.90		-24.90
Energy	0 kw		0.00		0.00
Trac scraper/loader	1	2,700	5.01		- 5.01
Concrete lot	85 ft^2/an	8,100	9.18		- 9.18
Bx spdr/daily use	1	3,800	11.74		-11.74
Diversion terrace	300 ft	75	0.12		- 0.12
Settlg basin/concret	360 ft^2	487	0.96		- 0.96
Infiltration area	10x140 ft	110	0.20		- 0.20
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		15,272	70.03	48.42	-21.61

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-40. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, DAILY SURFACE SPREAD, DIVERSION, SETTLING BASIN, DETENTION BASIN, WASTE WATER IRRIGATION, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	525 hrs		18.38		-18.38
Tractor	508 hrs		24.80		-24.80
Energy	800 kw		0.44		- 0.44
Trac scraper/loader	1	2,700	5.01		- 5.01
Concrete lot	85 ft^2/an	8,100	9.18		- 9.18
Bx spdr/daily use	1	3,800	11.74		-11.74
Diversion terrace	300 ft	75	0.12		- 0.12
Settlg basin/concret	360 ft^2	487	0.96		- 0.96
Detention basin	10,000 ft^3	607	1.10		- 1.10
Wastewater irrig/RO	1	1,554	4.93		- 4.93
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		17,323	76.66	48.42	-28.24

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-41. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, DAILY SURFACE SPREAD, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	667 hrs		11.67		-11.67
Tractor	667 hrs		18.31		-18.31
Energy	0 kw		0.00		0.00
Trac scraper/loader	1	2,700	2.50		- 2.50
Concrete lot	85 ft^2/an	16,200	9.18		- 9.18
Bx spdr/daily use	1	4,800	7.42		- 7.42
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		23,700	49.08	48.42	- 0.66

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-42. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, DAILY SURFACE SPREAD, DIVERSION, SETTLING BASIN, GRASS INFILTRATION AREA, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	673 hrs		11.78		-11.78
Tractor	669 hrs		18.37		-18.37
Energy	0 kw		0.00		0.00
Trac scraper/loader	1	2,700	2.50		- 2.50
Concrete lot	85 ft^2/an	16,200	9.18		- 9.18
Bx spdr/daily use	1	4,800	7.42		- 7.42
Diversion terrace	400 ft	100	0.09		- 0.09
Settle basin/concret	850 ft^2	1,670	1.64		- 1.64
Infiltration area	8x200 ft	128	0.12		- 0.12
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		25,598	51.09	48.42	- 2.67

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-43. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, DAILY SURFACE SPREAD, DIVERSION, SETTLING BASIN, DETENTION BASIN, WASTE WATER IRRIGATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	703 hrs		12.30		-12.30
Tractor	671 hrs		18.42		-18.42
Energy	1600 kw		0.44		- 0.44
Trac scraper/loader	1	2,700	2.50		- 2.50
Concrete lot	85 ft^2/an	16,200	9.18		- 9.18
Bx spdr/daily use	1	4,800	7.42		- 7.42
Diversion terrace	400 ft	100	0.09		- 0.09
Settling basin	850 ft^2	1,670	1.64		- 1.64
Detention basin	8700 ft^3	520	0.47		- 0.47
Wastewater irrig/RO	1	1,710	2.71		- 2.71
Nutrients					
N	124 lb/an yr			19.84	+19.84
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		27,700	55.18	48.42	- 6.76

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-44. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, PISTON PUMP, EARTHEN STORAGE, SURFACE SPREAD, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	453 hrs		15.85		-15.85
Tractor	490 hrs		36.53		-36.53
Energy	0 kw		0.00		0.00
Alleyway scraper	1	700	1.75		- 1.75
Piston pump/hollow	1	3,800	9.11		- 9.11
Concrete lot	85 ft^2/an	11,250	12.75		-12.75
Agitate/load pump	1	3,200	9.89		- 9.89
Tank wagon	1	5,400	12.95		-12.95
Storage basin	73,000 ft^3	9,100	15.93		-15.93
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		33,450	114.77	47.14	-67.63

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-45. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, PISTON PUMP, EARTHEN STORAGE, PLOWDOWN, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	453 hrs		15.85		-15.85
Tractor	490 hrs		36.53		-36.53
Energy	0 kw		0.00		0.00
Alleyway scraper	1	700	1.75		- 1.75
Piston pump/hollow	1	3,800	9.11		- 9.11
Concrete lot	85 ft^2/an	11,250	12.75		-12.75
Agitate/load pump	1	3,200	9.89		- 9.89
Tank wagon	1	5,400	12.95		-12.95
Storage basin	73,000 ft^3	9,100	15.93		-15.93
Nutrients					
N	149 lb/an yr			23.84	+23.84
P_2O_5	80 lb/an yr			14.40	+14.40
K_2O	158 lb/an yr			15.80	+15.80
Total		33,450	114.76	54.04	-60.72

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-46. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, PISTON PUMP, EARTHEN STORAGE, SURFACE SPREAD, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	730 hrs		12.77		-12.77
Tractor	820 hrs		30.57		-30.57
Energy	0 kw		0.00		0.00
Alleyway scraper	1	700	0.88		- 0.88
Piston pump/hollow	1	3,800	4.56		- 4.56
Concrete lot	85 ft^2/an	22,500	12.40		-12.40
Agitate/load pump	1	3,200	4.94		- 4.94
Tank wagon	1	7,000	8.51		- 8.51
Storage basin	146,000 ft^3	16,600	10.26		-10.26
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		33,450	84.89	47.14	-37.75

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-47. ECONOMIC DATA FOR DAIRY, FREE STALL, OPEN LOT, TRACTOR SCRAPE, PISTON PUMP, EARTHEN STORAGE, PLOWDOWN, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	730 hrs		12.77		-12.77
Tractor	820 hrs		30.57		-30.57
Energy	0 kw		0.00		0.00
Alleyway scraper	1	700	0.88		- 0.88
Piston pump/hollow	1	3,800	4.56		- 4.56
Concrete lot	85 ft^2/an	22,500	12.40		-12.40
Agitate/load pump	1	3,200	4.94		- 4.94
Tank wagon	1	7,000	8.51		- 8.51
Storage basin	146,000 ft^3	16,600	10.26		-10.26
Nutrients					
N	149 lb/an yr			23.84	+23.84
P_2O_5	80 lb/an yr			14.40	+14.40
K_2O	158 lb/an yr			15.80	+15.80
Total		33,450	84.89	54.04	-30.85

[a] Regions: cool humid, warm humid, hot humid.

TABLE A-48. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, FLUSH, LAGOON, WASTEWATER IRRIGATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	65 hrs		1.14		- 1.14
Tractor	40 hrs		2.99		- 2.99
Energy	2200 kw		0.61		- 0.61
Concrete floor	90 ft^2/an	19,600	11.10		-11.10
Gated tank	2 @ 2000 gal	2,600	2.68		- 2.68
Lagoons	575,000 ft^3	11,480	7.09		- 7.09
Recycle pump	1	525	0.81		- 0.81
Wastewater irrig/M	1	7,010	8.77		- 8.77
Nutrients					
N	32 lb/an yr			5.12	+ 5.12
P_2O_5	42 lb/an yr			7.56	+ 7.56
K_2O	100 lb/an yr			10.00	+10.00
Total		41,215	35.20	22.68	-12.52

[a] Regions: warm humid, warm arid, hot humid.

TABLE A-49. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, FLUSH, LAGOON, WASTEWATER IRRIGATION, 500 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	140 hrs		0.98		- 0.98
Tractor	100 hrs		1.60		- 1.60
Energy	5500 kw		0.61		- 0.61
Concrete floor	90 ft^2/an	46,500	10.54		-10.54
Gated tank	4 @ 2000 gal	5,200	2.14		- 2.14
Lagoons	1.4 M ft^3	28,700	7.09		- 7.09
Recycle pump	1	525	0.32		- 0.32
Wastewater irrig/M	1	13,360	6.68		- 6.68
Nutrients					
N	32 lb/an yr			5.12	+ 5.12
P_2O_5	42 lb/an yr			7.56	+ 7.56
K_2O	100 lb/an yr			10.00	+10.00
Total		94,285	29.97	22.68	- 7.29

[a] Regions: warm humid, warm arid, hot humid.

TABLE A-50. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, FLUSH, EARTHEN STORAGE, WASTEWATER IRRIGATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	130 hrs		2.27		- 2.27
Tractor	80 hrs		3.19		- 3.19
Energy	4400 kw		1.22		- 1.22
Concrete floor	90 ft^2/an	19,600	11.10		-11.10
Gated tank	2 @ 2000 gal	2,600	2.68		- 2.68
Storage basin	110,000 ft^3	3,360	2.09		- 2.09
Recycle pump	1	525	0.81		- 0.81
Wastewater irrig/M	1	7,010	8.77		- 8.77
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		33,095	32.14	47.14	+15.00

[a] Regions: warm humid, warm arid, hot humid.

TABLE A-51. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, FLUSH, EARTHEN STORAGE, WASTEWATER IRRIGATION, 500 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	280 hrs		1.96		- 1.96
Tractor	200 hrs		3.19		- 3.19
Energy	11,000 kw		1.22		- 1.22
Concrete floor	90 ft^2/cow	46,500	10.54		-10.54
Gated tank	4 @ 2000 gal	5,200	2.14		- 2.14
Storage basin	275,000 ft^3	8,400	2.08		- 2.08
Recycle pump	1	525	0.32		- 0.32
Wastewater irrig/M	1	13,360	6.68		- 6.68
Nutrients					
N	116 lb/an yr			18.56	+18.56
P_2O_5	76 lb/an yr			13.68	+13.68
K_2O	149 lb/an yr			14.90	+14.90
Total		73,985	28.14	47.14	+19.00

[a] Regions: warm humid, hot humid, warm arid.

TABLE A-52. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, FLUSH, SOLIDS SEPARATION, LAGOON, WASTEWATER IRRIGATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	115 hrs		2.01		- 2.01
Tractor	40 hrs		1.60		- 1.60
Energy	4400 kw		1.22		- 1.22
Concrete floor	90 ft^2/an	19,600	11.10		-11.10
Gated tank	2 @ 2000 gal	2,600	2.68		- 2.68
Lagoons	575,000 ft^3	11,480	7.09		- 7.09
Recycle pump	1	525	0.81		- 0.81
Wastewater irrig/M	1	7,010	8.77		- 8.77
Solids separator	1	9,200	11.03		-11.03
Nutrients					
N	26 lb/an yr			4.16	+ 4.16
P_2O_5	34 lb/an yr			6.12	+ 6.12
K_2O	80 lb/an yr			8.00	+ 8.00
Total		50,415	46.32	18.28	-28.04

[a] Regions: warm humid, hot humid, warm arid.

TABLE A-53. ECONOMIC DATA FOR DAIRY, CONFINED FREE STALL, FLUSH, SOLIDS SEPARATION, LAGOON, WASTEWATER IRRIGATION, 500 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	190 hrs		1.33		- 1.33
Tractor	100 hrs		1.60		- 1.60
Energy	11,000 kw		1.22		- 1.22
Concrete floor	90 ft^2/an	46,500	10.54		-10.54
Gated tank	4 @ 2000 gal	5,200	2.14		- 2.14
Lagoons	1.4 M gal	28,700	7.09		- 7.09
Recycle pump	1	525	0.32		- 0.32
Wastewater irrig/M	1	13,360	6.68		- 6.68
Solids separator	1	11,800	5.66		- 5.66
Nutrients					
N	26 lb/an yr			4.16	+ 4.16
P_2O_5	34 lb/an yr			6.12	+ 6.12
K_2O	80 lb/an yr			8.00	+ 8.00
Total		106,085	36.59	18.28	-18.31

[a] Regions: warm humid, hot humid, warm arid.

TABLE A-54. ECONOMIC DATA FOR DAIRY, PASTURE YEAR AROUND, FLUSH MILKING FACILITY, LAGOON, WASTEWATER IRRIGATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	50 hrs		0.88		- 0.88
Tractor	30 hrs		0.83		- 0.83
Energy	1100 kw		0.31		- 0.31
Concrete floor	6 ft^2/an	1,620	0.92		- 0.92
Gated tank	2 @ 1000 gal	2,000	2.06		- 2.06
Lagoon	180,000 ft^3	7,200	4.45		- 4.45
Wastewater irrig/M	1	7,010	8.77		- 8.77
Recycle pump	1	525	0.81		- 0.81
Nutrients					
N	7 lb/an yr			1.12	+ 1.12
P_2O_5	4 lb/an yr			0.72	+ 0.72
K_2O	14 lb/an yr			1.40	+ 1.40
Total		18,355	19.02	3.24	-15.78

[a] Regions: warm humid, hot humid.

TABLE A-55. ECONOMIC DATA FOR DAIRY, PASTURE YEAR AROUND, FLUSH MILKING FACILITY, LAGOON, WASTEWATER IRRIGATION, 500 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	125 hrs		0.88		- 0.88
Tractor	75 hrs		0.83		- 0.83
Energy	2750 kw		0.31		- 0.31
Concrete floor	6 ft^2/an	4,150	0.94		- 0.94
Gated tank	2 @ 2000 gal	3,600	1.48		- 1.48
Lagoon	450,000 ft^3	18,000	4.45		- 4.45
Wastewater irrig/M	1	13,360	6.68		- 6.68
Recycle pump	1	525	0.32		- 0.32
Nutrients					
N	7 lb/an yr			1.12	+ 1.12
P_2O_5	4 lb/an yr			0.72	+ 0.72
K_2O	14 lb/an yr			1.40	+ 1.40
Total		39,635	15.90	3.24	-12.66

[a] Regions: warm humid, hot humid.

TABLE A-56. ECONOMIC DATA FOR DAIRY, UNPAVED LOT, SHADE, TRACTOR SCRAPE, SURFACE STORAGE, TRUCK SPREAD, 300 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	686 hrs		8.00		- 8.00
Tractor	343 hrs		9.12		- 9.12
Energy	0 kw		0.00		0.00
Land	1	20,660	7.58		- 7.58
Front end loader	1	2,900	1.79		- 1.79
Truck spreader/box	1	17,600	14.68		-14.68
Nutrients					
N	76 lb/an yr			12.16	+12.16
P_2O_5	71 lb/an yr			12.78	+12.78
K_2O	141 lb/an yr			14.10	+14.10
Total		41,160	41.17	39.04	- 2.13

[a] Regions: warm arid, hot arid, hot humid.

TABLE A-57. ECONOMIC DATA FOR DAIRY, UNPAVED LOT, SHADE, TRACTOR SCRAPE, SURFACE STORAGE (6 MONTH), TRUCK SPREAD, DIVERSION, SETTLING BASIN, DETENTION BASIN, RUNOFF IRRIGATION, 300 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	766 hrs		8.94		- 8.94
Tractor	473 hrs		12.58		-12.58
Energy	365 kw		0.07		- 0.07
Land	500 ft^2/an	20,660	7.58		- 7.58
Front end loader	1	2,900	1.79		- 1.79
Truck spreader/box	1	17,600	14.68		-14.68
Diversion terrace	1300 ft	425	0.24		- 0.24
Detention basin	60,000 ft^3	3,600	2.17		- 2.17
Wastewater irrig/M	1	4,011	5.42		- 5.42
Concrete sump	1	650	0.36		- 0.36
Sump pump	1	2,980	4.03		- 4.03
Nutrients					
N	76 lb/an yr			12.16	+12.16
P_2O_5	71 lb/an yr			12.78	+12.78
K_2O	141 lb/an yr			14.10	+14.10
Total		52,826	57.85	39.04	-18.81

[a] Regions: warm arid, hot arid, hot humid.

TABLE A-58. ECONOMIC DATA FOR DAIRY, UNPAVED LOT, SHADE, TRACTOR SCRAPE, SURFACE STORAGE (6 MONTH), TRUCK SPREAD, 500 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	1143 hrs		8.00		- 8.00
Tractor	571 hrs		9.11		- 9.11
Energy	0 kw		0.00		0.00
Land	500 ft^2/an	34,433	7.58		- 7.58
Front end loader	1	2,900	1.08		- 1.08
Truck spreader/box	1	17,600	8.81		- 8.81
Nutrients					
N	76 lb/an yr			12.16	+12.16
P_2O_5	71 lb/an yr			12.78	+12.78
K_2O	141 lb/an yr			14.10	+14.10
Total		54,933	34.57	39.04	+ 4.47

[a] Regions: warm arid, hot arid, hot humid.

TABLE A-59. ECONOMIC DATA FOR DAIRY, UNPAVED LOT, SHADE, TRACTOR SCRAPE, SURFACE STORAGE (6 MONTH), TRUCK SPREAD, DIVERSION, SETTLING BASIN, DETENTION BASIN, RUNOFF IRRIGATION, 500 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	1343 hrs		9.40		- 9.40
Tractor	846 hrs		13.50		-13.50
Energy	900 kw		0.10		- 0.10
Land	500 ft^2/an	34,433	7.58		- 7.58
Front end loader	1	2,900	1.08		- 1.08
Truck spreader/box	1	17,600	8.81		- 8.81
Diversion terrace	2800 ft	710	0.24		- 0.24
Detention basin	100,000 ft^3	6,012	2.18		- 2.18
Wastewater irrig/M	1	4,780	3.88		- 3.88
Concrete sump	1	650	0.22		- 0.22
Sump pump	1	3,494	2.83		- 2.83
Nutrients					
N	76 lb/an yr			12.16	+12.16
P_2O_5	71 lb/an yr			12.78	+12.78
K_2O	141 lb/an yr			14.10	+14.10
Total		70,579	49.80	39.04	-10.76

[a]Regions: warm arid, hot arid, hot humid.

TABLE B-1. ECONOMIC DATA FOR FED BEEF, DRYLOT PAVED, PARTIAL SHELTER, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	55 hrs		1.92		-1.92
Tractor	55 hrs		3.00		-3.00
Energy	0 kw		0.00		0.00
Concrete floor/lot	55 ft^2/an	5,225	5.92		-5.92
Front end Loader	1	2,300	4.26		-4.26
Land - lot	0.07 ac	103	0.11		-0.11
Bx Spdr/periodic use	1	2,150	6.64		-6.64
Nutrients					
N	58 lb/an yr			9.28	+ 9.28
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		9,778	21.87	28.80	+ 6.93

[a] Regions: cool humid, cold humid.

TABLE B-2. ECONOMIC DATA FOR FED BEEF, DRYLOT PAVED, PARTIAL SHELTER, DETENTION/IRRIGATION, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	60 hrs		2.10		-2.10
Tractor	62 hrs		3.38		-3.38
Energy	0 kw		0.00		0.00
Concrete floor/lot	55 ft^2/an	5,225	5.92		-5.92
Front end Loader	1	2,300	4.26		-4.26
Land - lot	0.07 ac	103	0.11		-0.11
Bx Spdr/periodic use	1	2,150	6.64		-6.64
Diversion Terrace	150 ft	37	0.04		-0.04
Settlg Basin/concret	10 x 23 ft	487	0.69		-0.69
Detentn basin/earth	1500 ft^3	130	0.17		-0.17
Wastewater irrig/RO	1	2,440	4.78		-4.78
Nutrients					
N	58 lb/an yr			9.28	+ 9.28
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		12,872	28.10	28.80	+ 0.70

[a] Regions: cool humid, cold humid.

TABLE B-3. ECONOMIC DATA FOR FED BEEF, DRYLOT PAVED, PARTIAL SHELTER, GRASS INFILTRATION, 100 HEAD CAPACITY[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	60 hrs		2.10		-2.10
Tractor	62 hrs		3.38		-3.38
Energy	0 kw		0.00		0.00
Concrete floor/lot	55 ft^2/an	5,225	5.92		-5.92
Front End Loader	1	2,300	4.26		-4.26
Land - lot	0.07 ac	103	0.11		-0.11
Bx Spdr/periodic use	1	2,150	6.64		-6.64
Diversion terrace	148 ft	37	0.04		-0.04
Settlg Basin/concret	10 x 23 ft	487	0.69		-0.69
Infiltration area	10.5 x 400 ft	336	0.42		-0.42
Nutrients					
N	58 lb/an yr			9.28	+ 9.28
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		10,638	23.57	28.80	+ 5.23

[a] Regions: cool humid, cold humid.

TABLE B-4. ECONOMIC DATA FOR FED BEEF, DRYLOT PAVED, PARTIAL SHELTER, 400 HEAD CAPACITY[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	193 hrs		1.69		-1.69
Tractor	193 hrs		2.63		-2.63
Energy	0 kw		0.00		0.00
Concrete floor/lot	55 ft^2/an	20,900	5.92		-5.92
Front End Loader	1	2,700	1.25		-1.25
Land - lot	0.28 ac	412	0.11		-0.11
Bx Spdr/periodic use	1	2,600	2.01		-2.01
Nutrients					
N	58 lb/an yr			9.28	+ 9.28
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		26,612	13.62	28.80	+15.18

[a] Regions: cool humid, cold humid.

TABLE B-5. ECONOMIC DATA FOR FED BEEF, DRYLOT PAVED, PARTIAL SHELTER, DETENTION/IRRIGATION, 400 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	200 hrs		1.75		-1.75
Tractor	202 hrs		2.76		-2.76
Energy	0 kw		0.00		0.00
Concrete floor/lot	55 ft^2/an	20,900	5.92		-5.92
Front End Loader	1	2,700	1.25		-1.25
Land - lot	0.28 ac	412	0.11		-0.11
Bx Spdr/periodic use	1	2,600	2.01		-2.01
Diversion Terrace	280 ft	70	0.02		-0.02
Settlg Basin/concret	15 x 40 ft	1,150	0.40		-0.40
Detentn basin/earth	6000 ft^3	440	0.15		-0.15
Wastewater irrig/RO	1	2,440	1.19		-1.19
Nutrients					
N	58 lb/an yr			9.28	+ 9.28
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		30,712	15.57	28.80	+13.23

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[a] Regions: cool humid, cold humid.

TABLE B-6. ECONOMIC DATA FOR FED BEEF, DRYLOT PAVED, PARTIAL SHELTER, GRASS INFILTRATION, 400 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	200 hrs		1.75		-1.75
Tractor	202 hrs		2.76		-2.76
Energy	0 kw		0.00		0.00
Concrete floor/lot	55 ft^2/an	20,900	5.92		-5.92
Front End Loader	1	2,700	1.25		-1.25
Land - lot	0.28 ac	412	0.11		-0.11
Bx Spdr/periodic use	1	2,600	2.01		-2.01
Diversion terrace	280 ft	70	0.02		-0.02
Settlg Basin/concret	15 x 40 ft	1,150	0.40		-0.40
Infiltration area	10.5 x 700 ft	588	0.18		-0.18
Nutrients					
N	58 lb/an yr			9.28	+ 9.28
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		28,420	14.41	28.80	+14.39

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[a] Regions: cool humid, cold humid.

TABLE B-7. ECONOMIC DATA FOR FED BEEF, DRYLOT PAVED, PARTIAL SHELTER, 700 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	300 hrs		1.50		-1.50
Tractor	300 hrs		3.35		-3.35
Energy	0 kw		0.00		0.00
Concrete floor/lot	55 ft^2/an	36,575	5.92		-5.92
Front End Loader	1	2,900	0.77		-0.77
Land - lot	0.48 ac	721	0.11		-0.11
Bx Spdr/periodic use	1	3,800	1.68		-1.68
Nutrients					
N	58 lb/an yr			9.28	+ 9.28
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		43,996	13.33	28.80	+15.47

[a] Regions: cool humid, cold humid.

TABLE B-8. ECONOMIC DATA FOR FED BEEF, DRYLOT PAVED, PARTIAL SHELTER, DETENTION/IRRIGATION, 700 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	312 hrs		1.56		-1.56
Tractor	315 hrs		3.52		-3.52
Energy	0 kw		0.00		-0.00
Concrete floor/lot	55 ft^2/an	36,575	5.92		-5.92
Front End Loader	1	2,900	0.77		-0.77
Land - lot	0.48 ac	721	0.11		-0.11
Bx Spdr/periodic use	1	3,800	1.68		-1.68
Diversion Terrace	360 ft	90	0.01		-0.01
Settlg Basin/earth	20 x 53 ft	1,748	0.35		-0.35
Detentn Basin	10500 ft^3	530	0.10		-0.10
Wastewater irrig/RO	1	2,890	0.81		-0.81
Nutrients					
N	58 lb/an yr			9.28	+ 9.28
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		49,254	14.84	28.80	+13.96

[a] Regions: cool humid, cold humid.

TABLE B-9. ECONOMIC DATA FOR FED BEEF, DRYLOT PAVED, PARTIAL SHELTER, GRASS INFILTRATION, 700 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	312 hrs		1.56		-1.56
Tractor	315 hrs		3.52		-3.52
Energy	0 kw		0.00		0.00
Concrete floor/lot	55 ft^2/an	36,575	5.92		-5.92
Front End Loader	1	2,900	0.77		-0.77
Land - lot	0.48 ac	721	0.11		-0.11
Bx Spdr/periodic use	1	3,800	1.68		-1.68
Diversion Terrace	360 ft	90	0.01		-0.01
Settlg Basin/concret	20 x 53 ft	1,748	0.35		-0.35
Infiltration area	11 x 900 ft	792	0.14		-0.14
Nutrients					
N	58 lb/an yr			9.28	+ 9.28
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		46,626	14.07	28.80	+14.73

[a] Regions: cool humid, cold humid.

TABLE B-10. ECONOMIC DATA FOR FED BEEF, DRYLOT UNPAVED, PARTIAL SHELTER, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	35 hrs		1.22		-1.22
Tractor	35 hrs		1.91		-1.91
Energy	0 kw		0.00		0.00
Front End Loader	1	2,300	4.26		-4.26
Concrete floor	25 ft^2/an	2,375	2.69		-2.69
Land - lot	0.34 ac	516	0.57		-0.57
Bx Spdr/periodic use	1	2,150	3.59		-3.59
Nutrients					
N	53 lb/an yr			8.48	+ 8.48
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		7,341	14.25	28.00	+13.75

[a] Regions: cool humid, cold humid, cool arid, cold arid.

TABLE B-11. ECONOMIC DATA FOR FED BEEF, DRYLOT UNPAVED, PARTIAL SHELTER, DETENTION/IRRIGATION, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	42 hrs		1.47		-1.47
Tractor	44 hrs		2.40		-2.40
Energy	0 kw		0.00		0.00
Front End Loader	1	2,300	4.26		-4.26
Concrete floor	25 ft^2/an	2,375	2.69		-2.69
Land - lot	0.34 ac	516	0.57		-0.57
Bx Spdr/periodic use	1	2,150	4.42		-4.42
Diversion Terrace	325 ft	81	0.09		-0.09
Settlg Basin/earth	10 x 75 ft	280	0.39		-0.39
Detentn Basin/earth	7500 ft^3	470	0.63		-0.63
Wastewater irrig/RO	1	2,890	5.66		-5.66
Nutrients					
N	53 lb/an yr			8.48	+ 8.48
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		11,062	22.58	28.00	+ 5.42

[a]Regions: cool humid, cold humid, cool arid, cold arid

TABLE B-12. ECONOMIC DATA FOR FED BEEF, DRYLOT UNPAVED, PARTIAL SHELTER, GRASS INFILTRATION, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	38 hrs		1.47		-1.47
Tractor	38 hrs		2.40		-2.40
Energy	0 kw		0.00		0.00
Front End Loader	1	2,300	4.26		-4.26
Concrete floor	25 ft^2/an	2,375	2.69		-2.69
Land - lot	0.34 ac	516	0.57		-0.57
Bx Spdr/perodic use	1	2,150	4.42		-4.42
Diversion Terrace	325 ft	81	0.09		-0.09
Settlg Basin/earth	10 x 75 ft	280	0.42		-0.42
Infiltration Area	8 x 200 ft	128	0.16		-0.16
Nutrients					
N	53 lb/an yr			8.48	+ 8.48
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		7,830	16.49	28.00	+11.51

[a]Regions: cool humid, cold humid, cool arid, cold arid.

TABLE B-13. ECONOMIC DATA FOR FED BEEF, DRYLOT UNPAVED, PARTIAL SHELTER 400 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	113 hrs		0.99		-0.99
Tractor	113 hrs		1.54		-1.54
Energy	0 kw		0.00		0.00
Front End Loader	1	2,700	1.25		-1.25
Concrete floor	25 ft^2/an	9,500	2.69		-2.69
Land - lot	1.38 ac	2,064	0.57		-0.57
Bx Spdr/periodic use	1	2,600	1.34		-1.34
Nutrients					
N	53 lb/an yr			8.48	+ 8.48
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		16,864	8.38	28.00	+19.62

[a]Regions: cool humid, cold humid, cool arid, cold arid.

TABLE B-14. ECONOMIC DATA FOR FED BEEF, DRYLOT UNPAVED, PARTIAL SHELTER, DETENTION/IRRIGATION, 400 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	133 hrs		1.16		-1.16
Tractor	143 hrs		1.95		-1.95
Energy	0 kw		0.00		0.00
Front End Loader	1	2,700	1.25		-1.25
Concrete floor	25 ft^2/an	9,500	2.69		-2.69
Land - lot	1.38 ac	2,064	0.57		-0.57
Bx Spdr/periodic use	1	2,600	1.34		-1.34
Diversion Terrace	550 ft	157	0.04		-0.04
Settlg Basin/earth	20 x 150 ft	650	0.25		-0.25
Detentn Basin/earth	24000 ft^3	920	0.28		-0.28
Wastewater irrig/RO	1	3,290	1.61		-1.61
Nutrients					
N	53 lb/an yr			8.48	+ 8.48
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		21,881	11.15	28.00	+16.85

[a]Regions: cool humid, cold humid, cool arid, cold arid.

TABLE B-15. ECONOMIC DATA FOR FED BEEF, DRYLOT UNPAVED, PARTIAL SHELTER, GRASS INFILTRATION, 400 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	123 hrs		1.07		-1.07
Tractor	123 hrs		1.95		-1.95
Energy	0 kw		0.00		0.00
Front End Loader	1	2,700	1.25		-1.25
Concrete floor	25 ft^2/an	9,500	2.69		-2.69
Land - lot	1.38 ac	2,064	0.57		-0.57
Bx Spdr/periodic use	1	2,600	1.34		-1.34
Diversion Terrace	550 ft	157	0.04		-0.04
Settlg Basin/earth	20 x 150 ft	650	0.25		-0.25
Infiltration area	12 x 400 ft	384	0.12		-0.12
Nutrients					
N	53 lb/an yr			8.48	+ 8.48
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		18,055	9.47	28.00	+18.53

[a]Regions: cool humid, cold humid, cool arid, cold arid.

TABLE B-16. ECONOMIC DATA FOR FED BEEF, DRYLOT UNPAVED, PARTIAL SHELTER, 700 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	159 hrs		0.79		-0.79
Tractor	159 hrs		1.78		-1.78
Energy	0 kw		0.00		0.00
Front End Loader	1	2,900	0.77		-0.77
Concrete floor	25 ft^2/an	16,625	2.69		-2.69
Land - lot	2.41 ac	3,616	0.57		-0.57
Bx Spdr/periodic use	1	3,800	1.12		-1.12
Nutrients					
N	53 lb/an yr			8.48	+ 8.48
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		26,941	7.72	28.00	+20.28

[a]Regions: cool humid, cold humid, cool arid, cold arid.

TABLE B-17. ECONOMIC DATA FOR FED BEEF, DRYLOT UNPAVED, PARTIAL SHELTER, DETENTION/IRRIGATION, 700 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	203 lbs		1.01		-1.01
Tractor	225 lbs		2.52		-2.52
Energy	0 kw		0.00		0.00
Front End Loader	1	2,900	0.77		-0.77
Concrete floor	25 ft^2/an	16,625	2.69		-2.69
Land - lot	2.41 ac	3,616	0.57		-0.57
Bx Sprdr/periodic use	1	3,800	1.12		-1.12
Diversion Terrace	880 ft	220	0.04		-0.04
Settlg Basin/earth	25 x 210 ft	1,055	0.23		-0.23
Detentn Basin/earth	53000 ft^3	1,670	0.29		-0.29
Wastewater irrig/RO	1	4,090	1.14		-1.14
Nutrients					
N	53 lb/an yr			8.48	+ 8.48
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		33,976	10.38	28.00	+17.62

[a] Regions: cool humid, cold humid, cool arid, cold arid.

TABLE B-18. ECONOMIC DATA FOR FED BEEF, DRYLOT UNPAVED, PARTIAL SHELTER, GRASS INFILTRATION, 700 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	181 hrs		1.01		-1.01
Tractor	181 hrs		2.52		-2.52
Energy	0 kw		0.00		0.00
Front End Loader	1	2,900	0.77		-0.77
Concrete Floor	25 ft^2/an	16,625	2.69		-2.69
Land - lot	2.41 ac	3,616	0.57		-0.57
Bx spdr/periodic use	1	3,800	1.12		-1.12
Diversion Terrace	880 ft	220	0.04		-0.04
Settlg Basin/earth	25 x 210 ft	1,055	0.23		-0.23
Infiltration area	15 x 550 ft	660	0.12		-0.12
Nutrients					
N	53 lb/an yr			8.48	+ 8.48
P_2O_5	64 lb/an yr			11.52	+11.52
K_2O	80 lb/an yr			8.00	+ 8.00
Total		28,876	9.06	28.00	+18.94

[a] Regions: cool humid, cold humid, cool arid, cold arid.

TABLE B-19. ECONOMIC DATA FOR FED BEEF, TOTAL SHELTER, FULLY SLOTTED, 90 DAY STORAGE, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	70 hrs		2.45		- 2.45
Tractor	97 hrs		7.69		- 7.69
Energy	0 kw		0.00		0.00
Concrete slats	20 ft^2/an	4,400	4.99		- 4.99
Concrete pit	21000 ft^3	10,500	11.90		-11.90
Tank wagon	1	5,400	12.95		-12.95
Agitate/load pump	1	3,200	9.89		- 9.89
Nutrients					
N	68 lb/an yr			10.88	+10.88
P_2O_5	82 lb/an yr			14.76	+14.76
K_2O	95 lb/an yr			9.50	+ 9.50
Total		23,500	49.86	35.14	-14.72

[a] Regions: cool humid, cold humid.

TABLE B-20. ECONOMIC DATA FOR FED BEEF, TOTAL SHELTER, FULLY SLOTTED, 90 DAY STORAGE, PLOWDOWN, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	77 hrs		2.69		- 2.69
Tractor	104 hrs		8.25		- 8.25
Energy	0 kw		0.00		0.00
Concrete slats	20 ft^2/an	4,400	4.99		- 4.99
Concrete pit	21000 ft^3	10,500	11.90		-11.90
Tank wagon	1	5,400	12.95		-12.95
Agitate/load pump	1	3,200	9.89		- 9.89
Injector/soil,incorp	1	1,423	3.56		- 3.56
Nutrients					
N	88 lb/an yr			14.08	+14.08
P_2O_5	86 lb/an yr			15.48	+15.48
K_2O	101 lb/an yr			10.10	+10.10
Total		24,923	54.22	39.66	-14.56

[a] Regions: cool humid, cold humid.

TABLE B-21. ECONOMIC DATA FOR FED BEEF, TOTAL SHELTER, FULLY SLOTTED, 90 DAY STORAGE, 400 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	280 hrs		2.45		- 2.45
Tractor	376 hrs		7.46		- 7.46
Energy	0 kw		0.00		0.00
Concrete slats	20 ft^2/an	17,600	4.99		- 4.99
Concrete pit	84000 ft^3	42,000	11.90		-11.90
Tank wagon	1	5,400	3.24		- 3.24
Agitate/load pump	1	3,200	2.47		- 2.47
Nutrients					
N	68 lb/an yr			10.88	+10.88
P_2O_5	82 lb/an yr			14.76	+14.76
K_2O	95 lb/an yr			9.50	+ 9.50
Total		68,200	32.50	35.14	+ 2.64

[a] Regions: cool humid, cold humid.

TABLE B-22. ECONOMIC DATA FOR FED BEEF, TOTAL SHELTER, FULLY SLOTTED, 90 DAY STORAGE, PLOWDOWN, 400 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	308 hrs		2.69		- 2.69
Tractor	404 hrs		8.01		- 8.01
Energy	0 kw		0.00		0.00
Concrete slats	20 ft^2/an	17,600	4.99		- 4.99
Concrete pit	84000 ft^3	42,000	11.90		-11.90
Tank wagon	1	5,400	3.24		- 3.24
Agitate/load Pump	1	3,200	2.47		- 2.47
Injector/soil incorp	1	1,423	0.89		- 0.89
Nutrient					
N	88 lb/an yr			14.08	+14.08
P_2O_5	86 lb/an yr			15.48	+15.48
K_2O	101 lb/an yr			10.10	+10.10
Total		69,623	34.19	39.66	+ 5.47

[a] Regions: cool humid, cold humid.

B-23. ECONOMIC DATA FOR FED BEEF, TOTAL SHELTER,FULLY SLOTTED, 90 DAY STORAGE, 700 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	490 hrs		3.71		- 3.71
Tractor	679 hrs		7.69		- 7.69
Energy	0 kw		0.00		0.00
Concrete slats	20 ft^2/an	30,800	4.99		- 4.99
Concrete pit	147000 ft^3	73,500	11.90		-11.90
Tank wagon	1	7,000	2.50		- 2.50
Agitate/load pump	1	3,200	1.41		- 1.41
Nutrients					
N	68 lb/an yr			10.88	+10.88
P_2O_5	82 lb/an yr			14.76	+14.76
K_2O	95 lb/an yr			9.50	+ 9.50
Total		114,500	32.20	35.14	+ 2.94

[a] Regions: cool humid, cold humid

B-24. ECONOMIC DATA FOR FED BEEF, TOTAL SHELTER, FULLY SLOTTED, 90 DAY STORAGE, PLOWDOWN, 700 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	539 hrs		4.08		- 4.08
Tractor	728 hrs		8.25		- 8.25
Energy	0 kw		0.00		0.00
Concrete slats	20 ft^2/an	30,800	4.99		- 4.99
Concrete pit	147000 ft^3	73,500	11.90		-11.90
Tank wagon	1	7,000	2.50		- 2.50
Agitate/load pump	1	3,200	1.41		- 1.41
Injector/soil incorp	1	1,423	0.51		- 0.51
Nutrients					
N	88 lb/an yr			14.08	+14.08
P_2O_5	86 lb/an yr			15.48	+15.48
K_2O	101 lb/an yr			10.10	+10.10
Total		115,923	33.63	39.66	+ 6.03

[a] Regions: cool humid, cold humid.

TABLE B-25. ECONOMIC DATA FOR FED BEEF, UNPAVED LOT, NO SHELTER, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	58 hrs		2.03		-2.03
Tractor	58 hrs		4.54		-4.54
Energy	0 kw		0.00		0.00
Front End Loader	1	2,300	4.26		-4.26
Land -lot	400 ft^2/an	1,370	1.10		-1.10
Bx spdr/periodic use	1	2,150	4.43		-4.43
Nutrients					
N	45 lb/an yr			7.20	+7.20
P_2O_5	46 lb/an yr			8.28	+8.28
K_2O	64 lb/an yr			6.40	+6.40
Total		5,820	16.36	21.88	+5.52

[a] Regions: cool, warm, and hot arid.

TABLE B-26. ECONOMIC DATA FOR FED BEEF, UNPAVED LOT, NO SHELTER, DETENTION/IRRIGATION, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	62 hrs		2.17		-2.17
Tractor	63 hrs		4.93		-4.93
Energy	0 kw		0.00		0.00
Front End Loader	1	2,300	4.26		-4.26
Land - lot	400 ft^2/an	1,370	1.10		-1.10
Bx Spdr/periodic use	1	2,150	4.43		-4.43
Diversion Terrace	440 ft	110	0.12		-0.12
Settlg Basin/earth	10 x 200 ft	290	0.44		-0.44
Detentn Basin/earth	20000 ft^3	862	1.07		-1.07
Wastewater irrig/RO	1	2,890	5.66		-5.66
Nutrients					
N	45 lb/an yr			7.20	+7.20
P_2O_5	46 lb/an yr			8.28	+8.28
K_2O	64 lb/an yr			6.40	+6.40
Total		9,972	24.17	21.88	-2.29

[a] Regions: cool, warm, and hot humid.

TABLE B-27. ECONOMIC DATA FOR FED BEEF, UNPAVED LOT, NO SHELTER, 400 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	173 hrs		1.51		- 1.51
Tractor	173 hrs		1.14		- 1.14
Energy	0 kw		0.00		0.00
Front End Loader	1	2,700	1.25		- 1.25
Land -lot	400 ft^2/an	5,510	1.52		- 1.52
Bx Spdr/periodic use	1	2,600	1.34		- 1.34
Nutrients					
N	45 lb/an yr			7.20	+ 7.20
P_2O_5	46 lb/an yr			8.28	+ 8.28
K_2O	64 lb/an yr			6.40	+ 6.40
Total		10,810	6.75	21.88	+15.13

[a] Regions: cool, warm, and hot humid.

TABLE B-28. ECONOMIC DATA FOR FED BEEF, UNPAVED LOT, NO SHELTER, DETENTION/IRRIGATION, 400 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	183 hrs		1.60		-1.60
Tractor	188 hrs		1.43		-1.43
Energy	0 kw		0.00		0.00
Front End Loader	1	2,700	1.25		-1.25
Land - lot	400 ft^2/an	5,510	1.52		-1.52
Bx Spdr/periodic use	1	2,600	1.34		-1.34
Diversion Terrace	920	230	0.07		-0.07
Settlg Basin/earth	20 x 400 ft	1,060	0.40		-0.40
Detentn Basin/earth	80000 ft^3	2,320	0.72		-0.72
Wastewater irrig/RO	1	3,290	1.61		-1.61
Nutrients					
N	45 lb/an yr			7.20	+ 7.20
P_2O_5	46 lb/an yr			8.28	+ 8.28
K_2O	64 lb/an yr			6.40	+ 6.40
Total		17,710	9.94	21.88	+11.94

[a] Regions: cool, warm, and hot arid.

TABLE B-29. ECONOMIC DATA FOR FED BEEF, UNPAVED LOT, NO SHELTER, 700 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	290 hrs		1.45		-1.45
Tractor	290 hrs		3.24		-3.24
Energy	0 kw		0.00		0.00
Front End Loader	1	2,900	0.77		-0.77
Land - lot	400 ft^2/an	9,642	1.47		-1.47
Bx Spdr/periodic use	1	3,800	1.12		-1.12
Nutrients					
N	45 lb/an yr			7.20	+ 7.20
P_2O_5	46 lb/an yr			8.28	+ 8.28
K_2O	64 lb/an yr			6.40	+ 6.40
Total		16,342	8.05	21.88	+13.83

[a] Regions: cool, warm, and hot arid.

TABLE B-30. ECONOMIC DATA FOR FED BEEF, UNPAVED LOT, NO SHELTER, DETENTION/IRRIGATION, 700 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	312 hrs		1.56		-1.56
Tractor	323 hrs		3.61		-3.61
Energy	0 kw		0.00		0.00
Front End Loader	1	2,900	0.77		-0.77
Land - lot	400 ft^2/an	9,642	1.51		-1.51
Bx Spdr/periodic use	1	3,800	1.12		-1.12
Diversion Terrace	1140 ft	285	0.05		-0.05
Settlg Basin/earth	25 x 560 ft	1,705	0.37		-0.37
Detentn Basin/earth	140000 ft^3	3,765	0.66		-0.66
Wastewater irrig/RO	1	4,090	1.14		-1.14
Nutrients					
N	45 lb/an yr			7.20	+ 7.20
P_2O_5	46 lb/an yr			8.28	+ 8.28
K_2O	64 lb/an yr			6.40	+ 6.40
Total		26,187	10.79	21.88	+11.08

[a] Regions: cool, warm, and hot arid.

TABLE B-31. ECONOMIC DATA FOR BEEF COW-CALF, PAVED LOT, 40 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	13 hrs		1.14		- 1.14
Tractor	13 hrs		1.56		- 1.56
Energy	0 kw		0.00		0.00
Land - lot	30 ft^2/an	41	0.11		- 0.11
Front End Loader	1	2,300	10.66		-10.66
Bx Spdr/periodic use	1	2,150	11.09		-11.09
Nutrients					
N	80 lb/an yr			12.80	+12.80
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		4,491	24.55	38.10	+13.55

[a] Regions: cool humid, cold humid.

TABLE B-32. ECONOMIC DATA FOR BEEF COW-CALF, PAVED LOT, GRASS INFILTRATION, 40 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	15 hrs		1.31		- 1.31
Tractor	15 hrs		1.80		- 1.80
Energy	0 kw		0.00		0.00
Land - lot	30 ft^2/an	41	0.11		- 0.11
Front End Loader	1	2,300	10.66		-10.66
Bx Spdr/periodic use	1	2,150	11.09		-11.09
Diversion Terrace	100 ft	25	0.07		- 0.07
Settlg Basin/earth	10 x 23 ft	487	1.71		- 1.71
Infiltration area	12 x 400 ft	384	1.19		- 1.19
Nutrients					
N	80 lb/an yr			12.80	+12.80
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		5,387	27.94	38.10	+10.16

[a] Regions: cool humid, cold humid.

TABLE B-33. ECONOMIC DATA FOR BEEF COW-CALF, PAVED LOT, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	25 hrs		0.88		-0.88
Tractor	25 hrs		1.24		-1.24
Energy	0 kw		0.00		0.00
Land - lot	30 ft^2/an	103	0.11		-0.11
Front End Loader	1	2,300	4.26		-4.26
Bx Spdr/periodic use	1	2,150	4.43		-4.43
Nutrients					
N	80 lb/an yr			12.80	+12.80
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		4,553	10.92	38.10	+27.18

[a] Regions: cool humid, cold humid.

TABLE B-34. ECONOMIC DATA FOR BEEF COW-CALF, PAVED LOT, GRASS INFILTRATION, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	28 hrs		0.98		-0.98
Tractor	28 hrs		1.38		-1.38
Energy	0 kw		0.00		0.00
Land - lot	30 ft^2/an	103	0.11		-0.11
Front End Loader	1	2,300	4.26		-4.26
Bx Spdr/periodic use	1	2,150	4.43		-4.43
Diversion Terrace	150 ft	37	0.04		-0.04
Settlg Basin/earth	10 x 23 ft	487	0.69		-0.69
Infiltration area	12 x 450 ft	432	0.53		-0.53
Nutrients					
N	80 lb/an yr			12.80	+12.80
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		5,509	12.43	38.10	+25.67

[a] Regions: cool humid, cold humid.

TABLE B-35. ECONOMIC DATA FOR BEEF COW-CALF, PAVED LOT, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	44 hrs		0.77		-0.77
Tractor	44 hrs		1.09		-1.09
Energy	0 kw		0.00		0.00
Land - lot	30 ft^2/an	207	0.12		-0.12
Front End Loader	1	2,700	2.50		-2.50
Bx Spdr/periodic use	1	2,600	2.60		-2.60
Nutrients					
N	80 lb/an yr			12.80	+12.80
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		5,507	7.08	38.10	+31.02

[a] Regions: cool humid, cold humid.

TABLE B-36. ECONOMIC DATA FOR BEEF COW-CALF, PAVED LOT, GRASS INFILTRATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	51 hrs		0.89		-0.89
Tractor	51 hrs		1.26		-1.26
Energy	0 kw		0.00		0.00
Land - lot	30 ft^2/an	207	0.11		-0.11
Front End Loader	1	2,700	2.50		-2.50
Bx Spdr/periodic use	1	2,600	2.68		-2.68
Diversion Terrace	190 ft	48	0.03		-0.03
Settlg Basin/earth	10 x 30 ft	670	0.47		-0.47
Infiltration area	12 x 800 ft	768	0.47		-0.47
Nutrients					
N	80 lb/an yr			12.80	+12.80
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		6,993	8.42	38.10	+29.68

[a] Regions: cool humid, cold humid.

TABLE B-37. ECONOMIC DATA FOR BEEF COW-CALF, UNPAVED LOT, 40 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	10 hrs		0.88		- 0.88
Tractor	10 hrs		1.24		- 1.24
Energy	0 kw		0.00		0.00
Land - lot	150 ft^2/an	200	0.55		- 0.55
Front End Loader	1	2,300	10.66		-10.66
Bx Spdr/periodic use	1	2,150	11.07		-11.07
Nutrients					
N	75 lb/an yr			12.32	+12.32
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		4,650	24.39	37.62	+13.23

[a] Regions: cool and cold arid, cool, cold, and warm humid.

TABLE B-38. ECONOMIC DATA FOR BEEF COW-CALF, UNPAVED LOT, DETENTION/IRRIGATION, 40 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	14 hrs		1.22		- 1.22
Tractor	15 hrs		1.85		- 1.85
Energy	0 kw		0.00		0.00
Land - lot	150 ft^2/an	200	0.55		- 0.55
Front End Loader	1	2,300	10.66		-10.66
Bx Spdr/periodic use	1	2,150	11.06		-11.06
Diversion Terrace	190 ft	48	0.14		- 0.14
Settlg Basin/earth	10 x 30 ft	80	0.30		- 0.30
Detentn Basin/earth	3000 ft^3	260	0.80		- 0.80
Wastewater irrig/RO	1	2,440	11.94		-11.94
Nutrients					
N	75 lb/an yr			12.32	+12.32
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		7,478	38.53	37.62	- 0.91

[a] Regions: cool and cold arid, cold, cool and warm humid.

TABLE B-39. ECONOMIC DATA FOR BEEF COW-CALF, UNPAVED LOT, GRASS INFILTRATION, 40 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	12 hrs		1.05		- 1.05
Tractor	12 hrs		1.48		- 1.48
Energy	0 kw		0.00		0.00
Land - lot	150 ft^2/an	200	0.55		- 0.55
Front End Loader	1	2,300	10.66		-10.66
Bx Spdr/periodic use	1	2,150	11.06		-11.06
Diversion Terrace	190 ft	48	0.14		- 0.14
Settlg Basin/earth	10 x 30 ft	80	0.30		- 0.30
Infiltration area	10 x 150 ft	120	0.37		- 0.37
Nutrients					
N	75 lb/an yr			12.32	+12.32
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		4,898	25.61	37.62	+12.01

[a] Regions: cool and cold arid, cold, cool and warm humid.

TABLE B-40. ECONOMIC DATA FOR BEEF COW-CALF, UNPAVED LOT, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	20 hrs		0.70		-0.70
Tractor	20 hrs		1.03		-1.03
Energy	0 kw		0.00		0.00
Land - lot	150 ft^2/an	520	0.57		-0.57
Front End Loader	1	2,300	4.26		-4.26
Bx Spdr/periodic use	1	2,150	4.43		-4.43
Nutrients					
N	75 lb/an yr			12.32	+12.32
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		4,970	11.00	37.62	+26.62

[a] Regions: cool and cold arid, cool, cold, and warm humid.

TABLE B-41. ECONOMIC DATA FOR BEEF COW-CALF, UNPAVED LOT, DETENTION/IRRIGATION, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	27 hrs		0.94		-0.94
Tractor	29 hrs		1.49		-1.49
Energy	0 kw		0.00		0.00
Land - lot	150 ft^2/an	520	0.57		-0.57
Front End Loader	1	2,300	4.26		-4.26
Bx Spdr/periodic use	1	2,150	4.43		-4.43
Diversion Terrace	320 ft	80	0.09		-0.09
Settlg Basin/earth	10 x 75 ft	280	0.42		-0.42
Detentn Basin/earth	7500 ft^3	470	0.58		-0.58
Wastewater irrig/RO	1	2,890	5.66		-5.66
Nutrients					
N	75 lb/an yr			12.32	+12.32
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		8,690	18.45	37.62	+19.17

[a] Regions: cool and cold arid, cool, cold and warm humid.

TABLE B-42. ECONOMIC DATA FOR BEEF COW-CALF, UNPAVED LOT, GRASS INFILTRATION, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	23 hrs		0.80		-0.80
Tractor	23 hrs		1.18		-1.18
Energy	0 kw		0.00		0.00
Land - lot	150 ft^2/an	520	0.57		-0.57
Front End Loader	1	2,300	4.26		-4.26
Bx Spdr/periodic use	1	2,150	4.43		-4.43
Diversion Terrace	320	80	0.09		-0.09
Settlg Basin/earth	10 x 75 ft	280	0.42		-0.42
Infiltration area	10 x 150 ft	220	0.27		-0.27
Nutrients					
N	75 lb/an yr			12.32	+12.32
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		5,550	12.04	37.62	+25.58

[a] Regions: cool and cold arid, cold, cool and warm humid.

TABLE B-43. ECONOMIC DATA FOR BEEF COW-CALF, UNPAVED LOT, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	35 hrs		0.61		-0.61
Tractor	35 hrs		0.90		-0.90
Energy	0 kw		0.00		0.00
Land - lot	150 ft^2/an	1,040	0.57		-0.57
Front End Loader	1	2,700	2.50		-2.50
Bx Spdr/periodic use	1	2,600	2.68		-2.68
Nutrients					
N	75 lb/an yr			12.32	+12.32
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		6,340	7.27	37.62	+30.35

[a] Regions: cool and cold arid, cold, cool and warm humid.

TABLE B-44. ECONOMIC DATA FOR BEEF COW-CALF, UNPAVED LOT, DETENTION/IRRIGATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	49 hrs		0.86		-0.86
Tractor	53 hrs		1.36		-1.36
Energy	0 kw		0.00		0.00
Land - lot	150 ft^2/an	1,040	0.57		-0.57
Front End Loader	1	2,700	2.50		-2.50
Bx Spdr/periodic use	1	2,600	2.68		-2.68
Diversion Terrace	380 ft	95	0.05		-0.05
Settlg Basin/earth	15 x 100 ft	255	0.19		-0.19
Detentn Basin/earth	15000 ft^3	530	0.33		-0.33
Wastewater irrig/RO	1	3,090	3.02		-3.02
Nutrients					
N	75 lb/an yr			12.32	+12.32
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		10,310	11.57	37.62	+26.05

[a] Regions: cool and cold arid, cold, cool, and warm humid.

TABLE B-45. ECONOMIC DATA FOR BEEF COW-CALF, UNPAVED LOT, GRASS INFILTRATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	42 hrs		0.86		-0.86
Tractor	42 hrs		1.36		-1.36
Energy	0 kw		0.00		0.00
Land - lot	150 ft^2/an	1,040	0.57		-0.57
Front End Loader	1	2,700	2.50		-2.50
Bx Spdr/periodic use	1	2,600	2.68		-2.68
Diversion Terrace	380 ft	95	0.05		-0.05
Settlg Basin/earth	15 x 100 ft	255	0.19		-0.19
Infiltration area	12 x 400 ft	384	0.24		-0.24
Nutrients					
N	75 lb/an yr			12.32	+12.32
P_2O_5	85 lb/an yr			15.30	+15.30
K_2O	100 lb/an yr			10.00	+10.00
Total		7,074	8.46	37.62	+29.16

[a] Regions: cool and cold arid, cold, cool and warm humid.

TABLE C-1. ECONOMIC DATA FOR FED SWINE, PAVED LOT WITH SHELTER, SOLID HANDLING, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	16 hrs		1.12		-1.12
Tractor	16 hrs		1.43		-1.43
Energy	0 kw		0.00		0.00
Concrete floor	12 ft^2/an	690.00	1.56		-1.56
Bx spdr/periodic use	1	2,150.00	8.86		-8.86
Front-end loader	1	2,300.00	8.53		-8.53
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	12 lb/an yr			2.16	+2.16
K_2O	13 lb/an yr			1.30	+1.30
Totals		5,140.00	21.50	4.58	-16.92

[a] Regions: cool, cold, warm and hot humid.

TABLE C-2. ECONOMIC DATA FOR FED SWINE, PAVED LOT WITH SHELTER, SOLID HANDLING, DETENTION/IRRIGATION, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	18 hrs		1.26		-1.26
Tractor	19 hrs		1.69		-1.69
Energy	0 kw		0.00		0.00
Concrete floor	12 ft^2/an	690.00	1.56		-1.56
Bx spdr/periodic use	1	2,150.00	8.86		-8.86
Front-end loader	1	2,300.00	8.53		-8.53
Settling basin/earth	90 ft^2	307.00	0.82		-0.82
Detentn basin/earth	300 ft^3	130.00	0.32		-0.32
Wastewater irrig/RO	1	2,440.00	9.55		-9.55
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	12 lb/an yr			2.16	+2.16
K_2O	13 lb/an yr			1.30	+1.30
Totals		8,017.00	32.60	4.58	-28.02

[a] Regions: cool, cold, warm, and hot humid.

TABLE C-3. ECONOMIC DATA FOR FED SWINE, PAVED LOT WITH SHELTER, SOLID HANDLNG, GRASS INFILTRATION, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	18 hrs		1.26		-1.26
Tractor	16 hrs		1.43		-1.43
Energy	0 kw		0.00		0.00
Concrete floor	12 ft^2/an	690.00	1.56		-1.56
Bx spdr/periodic use	1	2,150.00	8.86		-8.86
Front-end loader	1	2,300.00	8.53		-8.53
Settlg basin/concret	90 ft^2	307.00	0.82		-0.82
Infiltration area	12x300 ft	288.00	0.71		-0.71
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	12 lb/an yr			2.16	+2.16
K_2O	13 lb/an yr			1.30	+1.30
Totals		5,735.00	23.17	4.58	-18.59

[a] Regions: cool, cold, warm and hot humid.

TABLE C-4. ECONOMIC DATA FOR FED SWINE, PAVED LOT, WITH SHELTER, SOLID HANDLING, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	64 hrs		1.12		-1.12
Tractor	64 hrs		1.43		-1.43
Energy	0 kw		0.00		0.00
Concrete floor	12 ft^2/an	2,760.00	1.56		-1.56
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Front-end loader	1	2,300.00	2.13		-2.13
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	12 lb/an yr			2.16	+2.16
K_2O	13 lb/an yr			1.30	+1.30
Totals		7,210	8.46	4.58	-3.88

[a] Regions: cool, cold, warm and hot humid.

TABLE C-5. ECONOMIC DATA FOR FED SWINE, PAVED LOT WITH SHELTER, SOLID HANDLING, DETENTION/IRRIGATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	67 hrs		1.17		-1.17
Tractor	70 hrs		1.56		-1.56
Energy	0 kw		0.00		0.00
Concrete floor	12 ft^2/an	2,760.00	1.56		-1.56
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Front-end loader	1	2,300.00	2.13		-2.13
Settling basin/earth	140 ft^2	460.00	0.31		-0.31
Detentn basin/earth	1200 ft^3	170.00	0.11		-0.11
Wastewater irrig/RO	1	2,400.00	2.39		-2.39
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	12 lb/an yr			2.16	+2.16
K_2O	13 lb/an yr			1.30	+1.30
Totals		10,280.00	11.44	4.58	-6.86

[a] Regions: cool, cold, warm and hot humid.

TABLE C-6. ECONOMIC DATA FOR FED SWINE, PAVED LOT WITH SHELTER, SOLID HANDLING, GRASS INFILTRATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	67 hrs		1.17		-1.17
Tractor	64 hrs		1.43		-1.43
Energy	0 kw		0.00		0.00
Concrete floor	12 ft^2/an	2,700.00	1.56		-1.56
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Front-end loader	1	2,300.00	2.13		-2.13
Settling basin/earth	140 ft^2	460.00	0.31		-0.31
Infiltration area	12x350 ft	336.00	0.21		-0.21
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	12 lb/an yr			2.16	+2.16
K_2O	13 lb/an yr			1.30	+1.30
Totals		7,946.00	9.02	4.58	-4.44

[a] Regions: cool, cold, warm and hot humid.

TABLE C-7. ECONOMIC DATA FOR FED SWINE, PAVED LOT WITH SHELTER, SOLID HANDLING, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	192 hrs		1.12		-1.12
Tractor	192 hrs		1.43		-1.43
Energy	0 kw		0.00		0.00
Concrete floor	12 ft^2/an	8,280.00	1.56		-1.56
Bx spdr/periodic use	1	2,600.00	0.89		-0.89
Front-end loader	1	2,700.00	0.83		-0.83
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	12 lb/an yr			2.16	+2.16
K_2O	13 lb/an yr			1.30	+1.30
Totals		13,580.00	5.84	4.58	-1.26

[a] Regions: cool, cold, warm, and hot humid.

TABLE C-8. ECONOMIC DATA FOR FED SWINE, PAVED LOT WITH SHELTER, DETENTION/IRRIGATION, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	196 hrs		1.14		-1.14
Tractor	199 hrs		1.48		-1.48
Energy	0 kw		0.00		0.00
Concrete floor	12 ft^2/an	8,280.00	1.56		-1.56
Bx spdr/periodic use	1	2,600.00	0.89		-0.89
Front-end loader	1	2,700.00	0.83		-0.83
Settlg basin/concret	170 ft^2	568.00	0.11		-0.11
Detentn basin/earth	3600 ft^3	252.00	0.05		-0.05
Wastewater irrig/RO	1	2,440.00	0.80		-0.80
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	12 lb/an yr			2.16	+2.16
K_2O	13 lb/an yr			1.30	+1.30
Totals		16,840.00	6.87	4.58	-2.29

[a] Regions: cool, cold, warm, and hot humid.

TABLE C-9. ECONOMIC DATA FOR FED SWINE, PAVED LOT WITH SHELTER, SOLID HANDLING, GRASS INFILTRATION, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	199 hrs		1.16		-1.16
Tractor	192 hrs		1.43		-1.43
Energy	0 kw		0.00		0.00
Concrete floor	12 ft^2/an	8,280.00	1.56		-1.56
Bx spdr/periodic use	1	2,600.00	0.89		-0.89
Front-end loader	1	2,700.00	0.83		-0.83
Settlg basin/concret	170 ft^2	568.00	0.11		-0.11
Infiltration area	12x600 ft	576.00	0.12		-0.12
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	12 lb/an yr			2.16	+2.16
K_2O	13 lb/an yr			1.30	+1.30
Totals		14,724.00	6.10	4.58	-1.52

[a] Regions:cool, cold, warm and hot humid.

TABLE C-10. ECONOMIC DATA FOR FED SWINE, PAVED LOT WITH SHELTER, SOLID HANDLING, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	320 hrs		1.12		-1.12
Tractor	320 hrs		1.43		-1.43
Energy	0 kw		0.00		0.00
Concrete floor	12 ft^2/an	13,800.00	1.56		-1.56
Bx spdr/periodic use	1	3,800.00	0.78		-0.78
Front-end loader	1	2,900.00	0.54		-0.54
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	12 lb/an yr			2.16	+2.16
K_2O	13 lb/an yr			1.30	+1.30
Totals		20,500.00	5.43	4.58	-0.85

[a] Regions: cool, cold, warm and hot humid.

TABLE C-11. ECONOMIC DATA FOR FED SWINE, PAVED LOT WITH SHELTER, SOLID HANDLING, DETENTION/IRRIGATION, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	325 hrs		1.14		-1.14
Tractor	328 hrs		1.46		-1.46
Energy	0 kw		0.00		0.00
Concrete floor	12 ft^2/an	13,800.00	1.56		-1.56
Bx spdr/periodic use	1	3,800.00	0.78		-0.78
Front-end loader	1	2,900.00	0.54		-0.54
Settlg basin/concret	300 ft^2	903.00	0.10		-0.10
Detentn basin/earth	6000 ft^3	490.00	0.06		-0.06
Wastewater irrig/RO	1	2,440.00	0.48		-0.48
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	12 lb/an yr			2.16	+2.16
K_2O	13 lb/an yr			1.30	+1.30
Totals		24,333.00	6.12	4.58	-1.54

[a] Regions: cool, cold, warm and hot humid.

TABLE C-12. ECONOMIC DATA FOR FED SWINE, PAVED LOT WITH SHELTER, SOLID HANDLING, GRASS INFILTRATION, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	329 hrs		1.15		-1.15
Tractor	320 hrs		1.43		-1.43
Energy	0 kw		0.00		0.00
Concrete floor	12 ft^2/an	13,800.00	1.56		-1.56
Bx spdr/periodic use	1	3,800.00	0.78		-0.78
Front-end loader	1	2,900.00	0.54		-0.54
Settlg basin/concret	300 ft^2	903.00	0.10		-0.10
Infiltration area	12x700 ft	672.00	0.08		-0.08
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	12 lb/an yr			2.16	+2.16
K_2O	13 lb/an yr			1.30	+1.30
Totals		22,075.00	5.65	4.58	-1.07

[a] Regions: cool, cold, warm and hot humid.

TABLE C-13. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT WITH SHELTER, SOLID HANDLING, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	8 hrs		0.56		-0.56
Tractor	8 hrs		0.73		-0.73
Energy	0 kw		0.00		0.00
Land	125 ft^2/an	215.00	0.47		-0.47
Bx spdr/periodic use	1	2,150.00	8.86		-8.86
Front-end loader	1	1,600.00	5.93		-5.93
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		3,965.00	16.55	3.34	-13.21

[a]Regions: Cool, cold, warm, and hot humid.

TABLE C-14. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT WITH SHELTER, SOLID HANDLING, DETENTION/IRRIGATION, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	13 hrs		0.91		-0.91
Tractor	16 hrs		1.45		-1.45
Energy	0 kw		0.00		0.00
Land	125 ft^2/an	215.00	0.47		-0.47
Bx spdr/periodic use	1	2,150.00	8.86		-8.86
Front-end loader	1	1,600.00	5.93		-5.93
Diversion terrace	160 ft^2	40.00	0.09		-0.09
Settling basin/earth	310 ft^2	161.00	0.43		-0.43
Detentn basin/earth	620 ft^3	365.00	0.90		-0.90
Wastewarer irrig/RO	1	2,440.00	9.55		-9.55
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		6,971.00	28.60	3.34	-25.26

[a]Regions: cool, cold, warm, and hot humid.

TABLE C-15. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT WITH SHELTER, SOLID HANDLING, GRASS INFILTRATION, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	12 hrs		0.84		-0.84
Tractor	8 hrs		0.73		-0.73
Energy	0 kw		0.00		0.00
Land	125 ft^2/an	215.00	0.47		-0.47
Bx spdr/periodic use	1	2,150.00	8.86		-8.86
Front-end loader	1	1,600.00	5.93		-5.93
Diversion terrace	160 ft	40.00	0.09		-0.09
Settling basin/earth	310 ft^2	161.00	0.43		-0.43
Infiltration area	10x50 ft	41.00	0.10		-0.10
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	5 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		4,207.00	17.45	3.34	-14.11

[a]Regions: cool, cold, warm, and hot humid.

TABLE C-16. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT WITH SHELTER, SOLID HANDLING, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	30 hrs		0.52		-0.52
Tractor	30 hrs		0.68		-0.68
Energy	0 kw		0.00		0.00
Land	125 ft^2/an	861.00	0.47		-0.47
Front-end loader	1	1,600.00	1.48		-1.48
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		4,611.00	5.38	3.34	-2.04

[a]Regions: cool, cold, warm, and hot humid.

TABLE C-17. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT WITH SHELTER, SOLID HANDLING, DETENTION/IRRIGATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	50 hrs		0.88		-0.88
Tractor	62 hrs		1.40		-1.40
Energy	0 kw		0.00		0.00
Land	125 ft^2/an	861.00	0.47		-0.47
Front-end loader	1	1,600.00	1.48		-1.48
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Diversion terrace	320 ft	80.00	0.05		-0.05
Settling basin/earth	1250 ft^2	393.00	0.26		-0.26
Detentn basin/earth	25,000 ft^3	880.00	0.54		-0.54
Wastewater irrig/RO	1	2,890.00	2.83		-2.83
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		8,854.00	10.13	3.34	-6.79

[a]Regions: cool, cold, warm, and hot humid.

TABLE C-18. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT WITH SHELTER, SOLID HANDLING, GRASS INFILTRATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	38 hrs		0.66		-0.66
Tractor	30 hrs		0.68		-0.68
Energy	0 kw		0.00		0.00
Land	125 ft^2/an	861.00	0.47		-0.47
Front-end loader	1	1,600.00	1.48		-1.48
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Diversion terrace	320 ft	80.00	0.05		-0.05
Settling basin/earth	1250 ft^2	393.00	0.26		-0.26
Infiltration area	10x100 ft	84.00	0.05		-0.05
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		5,168.00	5.88	3.34	-2.54

[a]Regions: cool, cold, warm, and hot humid.

TABLE C-19. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT WITH SHELTER, SOLID HANDLING, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	90 hrs		0.52		-0.52
Tractor	90 hrs		0.68		-0.68
Energy	0 kw		0.00		0.00
Land	125 ft^2/an	2,580.00	0.47		-0.47
Bx spdr/periodic use	1	2,150.00	0.74		-0.74
Front-end loader	1	1,600.00	0.49		-0.49
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		6,330.00	2.91	3.34	+0.43

[a] Regions: cool, cold, warm and hot humid.

TABLE C-20. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT WITH SHELTER, SOLID HANDLING, DETENTION/IRRIGATION, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	150 hrs		0.88		-0.88
Tractor	186 hrs		1.40		-1.40
Energy	0 kw		0.00		0.00
Land	125 ft^2/an	2,580.00	0.47		-0.47
Bx spdr/periodic use	1	2,150.00	0.74		-0.74
Front-end loader	1	1,600.00	0.49		-0.49
Diversion terrace	550 ft	140.00	0.03		-0.03
Settling basin/earth	3,750 ft^2	718.00	0.16		-0.16
Detentn basin/earth	75,000 ft^3	2,080.00	0.43		-0.43
Wastewater irrig/RO	1	3,290.00	1.07		-1.07
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		12,558.00	5.67	3.34	-2.33

[a] Regions: cool, cold, warm and hot humid.

TABLE C-21. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT WITH SHELTER, SOLID HANDLING, GRASS INFILTRATION, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	106 hrs		0.62		-0.62
Tractor	90 hrs		0.68		-0.68
Energy	0 kw		0.00		0.00
Land	125 ft^2/an	2,580.00	0.47		-0.47
Bx spdr/periodic use	1	2,150.00	0.74		-0.74
Front-end loader	1	1,600.00	0.49		-0.49
Diversion terrace	550 ft	140.00	0.03		-0.03
Settling basin/earth	3,750 ft^2	718.00	0.16		-0.16
Infiltration area	11x200 ft	168.00	0.03		-0.03
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		7,356.00	3.22	3.34	+0.12

[a]Regions: cool, cold, warm and hot humid.

TABLE C-22. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT WITH SHELTER, SOLID HANDLING, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	115 hrs		0.40		-0.40
Tractor	115 hrs		0.52		-0.52
Energy	0 kw		0.00		0.00
Land	125 ft^2/an	4,300.00	0.47		-0.47
Bx spdr/periodic use	1	2,600.00	0.54		-0.54
Front-end loader	1	2,000.00	0.37		-0.37
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		8,900.00	2.30	3.34	+1.04

[a]Regions: cool, cold, warm and hot humid.

TABLE C-23. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT WITH SHELTER, SOLID HANDLING, DETENTION/IRRIGATION, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	215 hrs		0.75		-0.75
Tractor	275 hrs		1.25		-1.25
Energy	0 kw		0.00		0.00
Land	125 ft^2/an	4,300.00	0.47		-0.47
Bx spdr/periodic use	1	2,600.00	0.54		-0.54
Front-end loader	1	2,000.00	0.37		-0.37
Diversion terrace	710 ft	178.00	0.02		-0.02
Settling basin/earth	6,250 ft^2	1,043.00	0.14		-0.14
Detentn basin/earth	125,000 ft^3	3,290.00	0.41		-0.41
Wastewater irrig/RO	1	4,090.00	0.80		-0.80
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		17,501.00	4.75	3.34	-1.41

[a] Regions: cool, cold, warm and hot humid.

TABLE C-24. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT WITH SHELTER, SOLID HANDLING, GRASS INFILTRATION, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	135 hrs		0.47		-0.47
Tractor	115 hrs		0.52		-0.52
Energy	0 kw		0.00		0.00
Land	125 ft^2/an	4,300.00	0.47		-0.47
Bx spdr/periodic use	1	2,600.00	0.54		-0.54
Front-end loader	1	2,000.00	0.37		-0.37
Diversion terrace	710 ft	178.00	0.02		-0.02
Settling basin/earth	6,250 ft^2	1,043.00	0.14		-0.14
Infiltration area	10x325 ft	275.00	0.03		-0.03
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		10,396.00	2.57	3.34	+0.77

[a] Regions: cool, cold, warm and hot humid.

TABLE C-25. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT, NO SHELTER, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	0		0.00		0.00
Tractor	0		0.00		0.00
Energy	0		0.00		0.00
Land	250 ft^2/an	215.00	0.47		-0.47
Nutrients					
N	0			0.00	0.00
P_2O_5	0			0.00	0.00
K_2O	0			0.00	0.00
Totals		215.00	0.47	0.00	-0.47

[a] Regions: warm and hot humid.

TABLE C-26. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT, NO SHELTER, DETENTION/IRRIGATION, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	0		0.00		0.00
Tractor	0		0.00		0.00
Energy	0		0.00		0.00
Land	250 ft^2/an	215.00	0.47		-0.47
Diversion terrace	225 ft	56.00	0.13		-0.13
Detentn basin/earth	5,200 ft^3	140.00	0.35		-0.35
Nutrients					
N	0			0.00	0.00
P_2O_5	0			0.00	0.00
K_2O	0			0.00	0.00
Totals		411.00	0.95	0.00	-0.95

[a] Regions: warm and hot humid.

TABLE C-27. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT, NO SHELTER, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	0		0.00		0.00
Tractor	0		0.00		0.00
Energy	0		0.00		0.00
Land	250 ft^2/an	861.00	0.47		-0.47
Nutrients					
N	0			0.00	0.00
P_2O_5	0			0.00	0.00
K_2O	0			0.00	0.00
Totals		861.00	0.47	0.00	-0.47

[a] Regions: warm and hot humid.

TABLE C-28. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT, NO SHELTER, DETENTION/IRRIGATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	0		0.00		0.00
Tractor	0		0.00		0.00
Energy	0		0.00		0.00
Land	250 ft^2/an	861.00	0.47		-0.47
Diversion terrace	450 ft	112.00	0.06		-0.06
Detentn basin/earth	21,000 ft^3	560.00	0.35		-0.35
Nutrients					
N	0			0.00	0.00
P_2O_5	0			0.00	0.00
K_2O	0			0.00	0.00
Totals		1,533.00	0.88	0.00	-0.88

[a] Regions: warm and hot humid.

TABLE C-29. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT, NO SHELTER, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	0		0.00		0.00
Tractor	0		0.00		0.00
Energy	0		0.00		0.00
Land	250 ft^2/an	2,580.00	0.47		-0.47
Nutrients					
N	0			0.00	0.00
P_2O_5	0			0.00	0.00
K_2O	0			0.00	0.00
Totals		2,580.00	0.47	0.00	-0.47

[a] Regions: warm and hot humid.

TABLE C-30. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT, NO SHELTER, DETENTION/IRRIGATION, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	0		0.00		0.00
Tractor	0		0.00		0.00
Energy	0		0.00		0.00
Land	250 ft^2/an	2,580.00	0.47		-0.47
Diversion terrace	800 ft	200.00	0.03		-0.03
Detentn basin/earth	62,500 ft^3	1,680.00	0.35		-0.35
Nutrients					
N	0			0.00	0.00
P_2O_5	0			0.00	0.00
K_2O	0			0.00	0.00
Totals		4,460.00	0.85	0.00	-0.85

[a] Regions: warm and hot humid.

TABLE C-31. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT, NO SHELTER, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	0		0.00		0.00
Tractor	0		0.00		0.00
Energy	0		0.00		0.00
Land	250 ft^2/an	4,300.00	0.47		-0.47
Nutrients					
N	0			0.00	0.00
P_2O_5	0			0.00	0.00
K_2O	0			0.00	0.00
Totals		4,300	0.47	0.00	-0.47

[a] Regions: warm and hot humid.

TABLE C-32. ECONOMIC DATA FOR FED SWINE, UNPAVED LOT, NO SHELTER, DETENTION/IRRIGATION, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	0		0.00		0.00
Tractor	0		0.00		0.00
Energy	0		0.00		0.00
Land	250 ft^2/an	4,300.00	0.47		-0.47
Diversion terrace	1,000 ft	250.00	0.03		-0.03
Detentn basin/earth	104,000 ft^3	2,800.00	0.35		-0.35
Nutrients					
N	0			0.00	0.00
P_2O_5	0			0.00	0.00
K_2O	0			0.00	0.00
Totals		7,350.00	0.85	0.00	-0.85

[a] Regions: warm and hot humid.

TABLE C-33. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, TOTAL SLATS, PIT STORAGE (6 MO), LIQUID HANDLING, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	30 hrs		0.52		-0.52
Tractor	30 hrs		1.17		-1.17
Energy	0 kw		0.00		0.00
Concrete slats	7 ft^2/an	3,080.00	2.54		-2.54
Concrete pit	56 ft^3/an	3,360.00	1.90		-1.90
Tank wagon	1	4,400.00	5.28		-5.28
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	15 lb/an yr			2.70	+2.70
K_2O	16 lb/an yr			1.60	+1.60
Totals		10,840.00	11.42	5.58	-5.84

[a] Regions: cool, cold, warm, and hot humid.

TABLE C-34. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, TOTAL SLATS, PIT STORAGE (6 MO), LIQUID HANDLING, INJECTION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	35 hrs		0.56		-0.56
Tractor	35 hrs		1.25		-1.25
Energy	0 kw		0.00		0.00
Concrete slats	7 ft^2/an	3,080.00	2.54		-2.54
Concrete pit	56 ft^3/an	3,360.00	1.90		-1.90
Tank wagon	1	4,400.00	5.28		-5.28
Injector/soil incorp	1	1,400.00	1.75		-1.75
Nutrients					
N	11 lb/an yr			1.76	+1.76
P_2O_5	17 lb/an yr			3.06	+3.06
K_2O	18 lb/an yr			1.80	+1.80
Totals		12,240.00	13.28	6.62	-6.66

[a] Regions: cool, cold, warm, and hot humid.

TABLE C-35. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, TOTAL SLATS, PIT STORAGE (6 MO), LIQUID HANDLING, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	55 hrs		0.32		-0.32
Tractor	55 hrs		0.72		-0.72
Energy	0 kw		0.00		0.00
Concrete slats	7 ft^2/an	9,240.00	2.58		-2.58
Concrete pit	56 ft^3/an	10,080.00	1.90		-1.90
Tank wagon	1	6,000.00	2.09		-2.09
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	15 lb/an yr			2.70	+2.70
K_2O	16 lb/an yr			1.60	+1.60
Totals		25,320.00	7.62	5.58	-2.04

[a] Regions: cool, cold, warm, and hot humid.

TABLE C-36. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, TOTAL SLATS, PIT STORAGE (6 MO), LIQUID HANDLING, INJECTION, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	58 hrs		0.34		-0.34
Tractor	58 hrs		0.76		-0.76
Energy	0 kw		0.00		0.00
Concrete slats	7 ft^2/an	9,240.00	2.58		-2.58
Concrete pit	56 ft^3/an	10,080.00	1.90		-1.90
Tank wagon	1	6,000.00	2.09		-2.09
Injector/soil incorp	1	1,400.00	0.58		-0.58
Nutrients					
N	11 lb/an yr			1.76	+1.76
P_2O_5	17 lb/an yr			3.06	+3.06
K_2O	18 lb/an yr			1.80	+1.80
Totals		26,720.00	8.26	6.62	-1.64

[a] Regions: cool, cold, warm, and hot humid.

TABLE C-37. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, TOTAL SLATS, PIT STORAGE (6 MO), LIQUID HANDLING, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	90 hrs		0.31		-0.31
Tractor	90 hrs		0.70		-0.70
Energy	0 kw		0.00		0.00
Concrete slats	7 ft^2/an	15,400.00	2.54		-2.54
Concrete pit	56 ft^3/an	16,800.00	1.90		-1.90
Tank wagon	1	6,000.00	1.44		-1.44
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	12 lb/an yr			2.70	+2.70
K_2O	16 lb/an yr			1.60	+1.60
Totals		38,200.00	6.90	5.58	-1.32

[a]Regions: cool, cold, warm and hot humid.

TABLE C-38. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, TOTAL SLATS, PIT STORAGE (6 MO), LIQUID HANDLING, INJECTION, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	92 hrs		0.33		-0.33
Tractor	92 hrs		0.74		-0.74
Energy	0 kw		0.00		0.00
Concrete slats	7 ft^2/an	15,400.00	2.54		-2.54
Concrete pit	56 ft^3/an	16,800.00	1.90		-1.90
Tank wagon	1	6,000.00	1.44		-1.44
Injector/soil incorp	1	1,400.00	0.35		-0.35
Nutrients					
N	11 lb/an yr			1.76	+1.76
P_2O_5	17 lb/an yr			3.06	+3.06
K_2O	18 lb/an yr			1.80	+1.80
Totals		39,600.00	7.31	6.62	-0.69

[a]Regions: cool, cold, warm and hot humid.

TABLE C-39. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, PARTIAL SLATS, SHALLOW PIT DISCHARGE TO LAGOON, WASTEWATER DISPOSAL, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	22 hrs		0.39		-0.39
Tractor	14 hrs		0.29		-0.29
Energy	0 kw		0.00		0.00
Concrete slats	3 ft^2/an	1,080.00	0.89		-0.89
Concrete pit	12 ft^3/an	720.00	0.41		-0.41
Concrete floor	4 ft^2/an	1,320.00	1.09		-1.09
Lagoon	54,000 ft^3	3,400.00	2.10		-2.10
Wastewtr irrig/manur	1	2,440.00	3.05		-3.05
Nutrients					
N	2 lb/an yr			0.32	+0.32
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		8,960.00	8.22	2.86	-5.36

[a] Regions: warm and hot humid.

TABLE C-40. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, PARTIAL SLATS, SHALLOW PIT DISCHARGE TO LAGOON, WASTEWATER DISPOSAL, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	38 hrs		0.22		-0.22
Tractor	42 hrs		0.29		-0.29
Energy	0 kw		0.00		0.00
Concrete slats	3 ft^2/an	3,240.00	0.89		-0.89
Concrete pit	12 ft^3/an	2,160.00	0.41		-0.41
Concrete floor	4 ft^2/an	3,960.00	1.09		-1.09
Lagoon	162,000 ft^3	10,000.00	2.06		-2.06
Wastewtr irrig/manur	1	2,890.00	1.20		-1.20
Nutrients					
N	2 lb/an yr			0.32	+0.32
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		22,250.00	6.16	2.86	-3.30

[a] Regions: warm and hot humid.

TABLE C-41. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, PARTIAL SLATS, SHALLOW PIT DISCHARGE TO LAGOON, WASTEWATER DISPOSAL, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	52 hrs		0.18		-0.18
Tractor	70 hrs		0.29		-0.29
Energy	0 kw		0.00		0.00
Concrete slats	3 ft^2/an	5,400.00	0.89		-0.89
Concrete pit	12 ft^3/an	3,600.00	0.41		-0.41
Concrete floor	4 ft^2/an	6,600.00	1.09		-1.09
Lagoon	270,000 ft^3	16,800.00	2.08		-2.08
Wastewtr irrig/manur	1	3,290.00	0.82		-0.82
Nutrients					
N	2 lb/an yr			0.32	+0.32
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		35,690.00	5.75	2.86	-2.89

[a]Regions: warm and hot humid.

TABLE C-42. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, FLUSH GUTTER TO LAGOON, WASTEWATER DISPOSAL, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	18 hrs		0.32		-0.32
Tractor	14 hrs		0.29		-0.29
Energy	0 kw		0.00		0.00
Concrete floor	8 ft^2/an	2,164.00	1.23		-1.23
Siphon tank	1	300.00	0.38		-0.38
Recycle pump/pipe	1	425.00	0.66		-0.66
Lagoon	54,000 ft^3	3,200.00	1.98		-1.98
Wastewtr irrig/manur	1	2,440.00	3.05		-3.05
Nutrients					
N	2 lb/an yr			0.32	+0.32
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		8,529.00	7.90	2.86	-5.04

[a]Regions: cool, warm and hot humid.

TABLE C-43. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, FLUSH GUTTER TO LAGOON, WASTEWATER DISPOSAL, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	26 hrs		0.15		-0.15
Tractor	42 hrs		0.29		-0.29
Energy	0 kw		0.00		0.00
Concrete floor	8 ft^2/an	6,492.00	1.23		-1.23
Siphon tank	2	500.00	0.21		-0.21
Recycle pump/pipe	1	475.00	0.24		-0.24
Lagoon	162,000 ft^3	9,600.00	1.98		-1.98
Wastewtr irrig/manur	1	2,890.00	1.20		-1.20
Nutrients					
N	2 lb/an yr			0.32	+0.32
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		19,957.00	5.30	2.86	-2.44

[a]Regions: cool, warm and hot humid.

TABLE C-44. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, FLUSH GUTTER TO LAGOON, WASTEWATER DISPOSAL, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	34 hrs		0.12		-0.12
Tractor	70 hrs		0.29		-0.29
Energy	0 kw		0.00		0.00
Concrete floor	8 ft^2/an	10,820.00	1.23		-1.23
Siphon tank	4	800.00	0.17		-0.17
Recycle pump/pipe	1	525.00	0.16		-0.16
Lagoon	270,000 ft^3	16,000.00	1.98		-1.98
Wastewtr irrig/manur	1	3,290.00	0.82		-0.82
Nutrients					
N	2 lb/an yr			0.32	+0.32
P_2O_5	8 lb/an yr			1.44	+1.44
K_2O	11 lb/an yr			1.10	+1.10
Totals		31,435.00	4.77	2.86	-1.91

[a]Regions: cool, warm and hot humid.

TABLE C-45. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, NARROW GUTTER DISCHARGE TO STORAGE BASIN, LIQUID HANDLING, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	55 hrs		0.96		-0.96
Tractor	30 hrs		1.17		-1.17
Energy	0 kw		0.00		0.00
Concrete floor	7 ft^2/an[b]	2,106.00	1.19		-1.19
Tank wagon	1	4,400.00	5.28		-5.28
Storage basin	56 ft^3/an	734.00	0.45		-0.45
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	15 lb/an yr			2.70	+2.70
K_2O	16 lb/an yr			1.60	+1.60
Totals		7,240.00	9.06	5.58	-3.48

[a] Regions: cool and cold humid.

[b] Gutter at $4.00 per linear foot.

TABLE C-46. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, NARROW GUTTER DISCHARGE TO STORAGE BASIN, LIQUID HANDLING, INJECTION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	58 hrs		1.01		-1.01
Tractor	33 hrs		1.29		-1.29
Energy	0 kw		0.00		0.00
Concrete floor	7 ft^2/an[b]	2,106.00	1.19		-1.19
Tank wagon	1	4,400.00	5.28		-5.28
Storage basin	56 ft^3/an	734.00	0.45		-0.45
Injector/soil incorp	1	1,400.00	1.75		-1.75
Nutrients					
N	11 lb/an yr			1.76	+1.76
P_2O_5	17 lb/an yr			3.06	+3.06
K_2O	18 lb/an yr			1.80	+1.80
Totals		8,640.00	10.98	6.62	-4.36

[a] Regions: cool and cold humid.

[b] Gutter at $4.00 per linear ft.

TABLE C-47. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, NARROW GUTTER DISCHARGE TO STORAGE BASIN, LIQUID HANDLING, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	80 hrs		0.47		-0.47
Tractor	55 hrs		0.72		-0.72
Energy	0 kw		0.00		0.00
Concrete floor	7 ft^2/an^b	6,318.00	1.20		-1.20
Tank wagon	1	6,000.00	2.40		-2.40
Storage basin	56 ft^3/an	1,200.00	0.25		-0.25
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	15 lb/an yr			2.70	+2.70
K_2O	16 lb/an yr			1.60	+1.60
Totals		13,518.00	5.03	5.58	+0.55

[a] Regions: cool and cold humid.

[b] Gutter at $4.00 per linear ft.

TABLE C-48. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, NARROW GUTTER DISCHARGE TO STORAGE BASIN, LIQUID HANDLING, INJECTION, 600 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Return ($/an yr)	Annual Net System Return ($/an yr)
Labor	86 hrs		0.50		-0.50
Tractor	61 hrs		0.80		-0.80
Energy	0 kw		0.00		0.00
Concrete floor	7 ft^2/an^b	6,318.00	1.20		-1.20
Tank wagon	1	6,000.00	2.40		-2.40
Storage basin	56 ft^3/an	1,200.00	0.25		-0.25
Injector/soil incorp	1	1,400.00	0.58		-0.58
Nutrients					
N	11 lb/an yr			1.76	+1.76
P_2O_5	17 lb/an yr			3.06	+3.06
K_2O	18 lb/an yr			1.80	+1.80
Totals		14,918.00	5.73	6.62	+0.89

[a] Regions: cool and cold humid.

[b] Gutter at $4.00 per linear ft.

TABLE C-49. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, NARROW GUTTER DISCHARGE TO STORAGE BASIN, LIQUID HANDLING, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	115 hrs		0.40		-0.40
Tractor	90 hrs		0.70		-0.70
Energy	0 kw		0.00		0.00
Concrete floor	7 ft^2/an[b]	10,530.00	1.19		-1.19
Tank wagon	1	6,000.00	1.44		-1.44
Storage basin	56 ft^3/an	1,670.00	0.21		-0.21
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	15 lb/an yr			2.70	+2.70
K_2O	16 lb/an yr			1.60	+1.60
Totals		18,200.00	3.95	5.58	+1.63

[a] Regions: cool and cold humid.

[b] Gutter at $4.00 per linear ft.

TABLE C-50. ECONOMIC DATA FOR FED SWINE, TOTAL SHELTER, NARROW GUTTER DISCHARGE TO STORAGE BASIN, LIQUID HANDLING, INJECTION, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	121 hrs		0.42		-0.42
Tractor	96 hrs		0.75		-0.75
Energy	0 kw		0.00		0.00
Concrete floor	7 ft^2/an[b]	10,530.00	1.19		-1.19
Tank wagon	1	6,000.00	1.44		-1.44
Storage basin	56 ft^3/an	1,670.00	0.21		-0.21
Injector/soil incorp	1	1,400.00	0.35		-0.35
Nutrients					
N	11 lb/an yr			1.76	+1.76
P_2O_5	17 lb/an yr			3.06	+3.06
K_2O	18 lb/an yr			1.80	+1.80
Totals		19,600.00	4.36	6.62	+2.26

[a] Regions: cool and cold humid.

[b] Gutter at $4.00 per linear ft.

TABLE C-51. ECONOMIC DATA FOR SWINE BREEDING, PAVED LOT, FARROWING HOUSE, SOLID HANDLING, 20 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	26 hrs		4.55		-4.55
Tractor	10 hrs		2.73		-2.73
Energy	0 kw		0.00		0.00
Concrete floor	100 ft^2/an	950.00	5.38		-5.38
Bx spdr/daily use	1	2,150.00	33.22		-33.22
Nutrients					
N	6 lb/an yr			0.96	+0.96
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	7 lb/an yr			0.70	+0.70
Totals		3,100.00	45.88	2.20	-43.68

[a]Regions: cool, cold, warm and hot humid.

TABLE C-52. ECONOMIC DATA FOR SWINE BREEDING, PAVED LOT, FARROWING HOUSE, SOLID HANDLING, GRASS INFILTRATION, 20 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	26 hrs		4.55		-4.55
Tractor	10 hrs		2.73		-2.73
Energy	0 kw		0.00		0.00
Concrete floor	100 ft^2/an	950.00	5.38		-5.38
Bx spdr/daily use	1	2,150.00	33.22		-33.22
Settlg basin/concret	180 ft^2	459.00	2.60		-2.60
Infiltration area	12x150 ft	144.00	0.89		-0.89
Nutrients					
N	6 lb/an yr			0.96	+0.96
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	7 lb/an yr			0.70	+0.70
Totals		3,703.00	49.37	2.20	-47.17

[a]Regions: cool, cold, warm and hot humid.

TABLE C-53. ECONOMIC DATA FOR SWINE BREEDING, PAVED LOT, FARROWING HOUSE, SOLID HANDLING, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	50 hrs		3.50		-3.50
Tractor	10 hrs		1.09		-1.09
Energy	0 kw		0.00		0.00
Concrete floor	100 ft^2/an	2,375.00	5.38		-5.38
Bx spdr/daily use	1	2,150.00	13.29		-13.29
Nutrients					
N	6 lb/an yr			0.96	+0.96
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	7 lb/an yr			0.70	+0.70
Totals		4,525.00	23.26	2.20	-21.06

[a]Regions: cool, cold, warm and hot humid.

TABLE C-54. ECONOMIC DATA FOR SWINE BREEDING, PAVED LOT, FARROWING HOUSE, SOLID HANDLING, GRASS INFILTRATION, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	50 hrs		3.50		-3.50
Tractor	10 hrs		1.09		-1.09
Energy	0 kw		0.00		0.00
Concrete floor	100 ft^2/an	2,375.00	5.38		-5.38
Bx spdr/daily use	1	2,150.00	13.29		-13.29
Settlg basin/concret	230 ft^2	591.00	1.34		-1.34
Infiltration area	12x225 ft	216.00	0.53		-0.53
Nutrients					
N	6 lb/an yr			0.96	+0.96
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	7 lb/an yr			0.70	+0.70
Totals		5,332.00	25.13	2.20	-22.93

[a]Regions: cool, cold, warm and hot humid.

TABLE C-55. ECONOMIC DATA FOR SWINE BREEDING, PAVED LOT, FARROWING HOUSE, SOLID HANDLING, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	90 hrs		3.15		-3.15
Tractor	10 hrs		0.55		-0.55
Energy	0 kw		0.00		0.00
Concrete floor	100 ft^2/an	4,750.00	5.38		-5.38
Bx spdr/daily use	1	2,150.00	6.64		-6.64
Nutrients					
N	6 lb/an yr			0.96	+0.96
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	7 lb/an yr			0.70	+0.70
Totals		6,900.00	15.72	2.20	-13.52

[a] Regions: cool, cold, warm and hot humid.

TABLE C-56. ECONOMIC DATA FOR SWINE BREEDING, PAVED LOT, FARROWING HOUSE, SOLID HANDLING, GRASS INFILTRATION, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	90 hrs		3.15		-3.15
Tractor	10 hrs		0.55		-0.55
Energy	0 kw		0.00		0.00
Concrete floor	100 ft^2/an	4,750.00	5.38		-5.38
Bx spdr/daily use	1	2,150.00	6.64		-6.64
Settlg basin/concret	25 ft^2	668.00	0.76		-0.76
Infiltration area	12x300 ft	288.00	0.36		-0.36
Nutrients					
N	6 lb/an yr			0.96	+0.96
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.70	+0.70
Totals		7,856.00	16.83	2.20	-14.63

[a] Regions: cool, cold, warm and hot humid.

TABLE C-57. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, CONCRETE FLOOR, SOLID HANDLING, 20 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	52 hrs		9.10		-9.10
Tractor	20 hrs		5.46		-5.46
Energy	0 kw		0.00		0.00
Concrete floor	35 ft^2/an	675.00	3.82		-3.82
Bx spdr/daily use	1	2,150.00	33.22		-33.22
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	4 lb/an yr			0.72	+0.72
K_2O	8 lb/an yr			0.80	+0.80
Totals		2,825.00	51.60	2.80	-48.80

[a]Regions: cool, cold, warm and hot humid.

TABLE C-58. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, CONCRETE FLOOR, SOLID HANDLING, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	100 hrs		7.00		-7.00
Tractor	20 hrs		2.18		-2.18
Energy	0 kw		0.00		0.00
Concrete floor	35 ft^2/an	1,688.00	3.83		-3.83
Bx spdr/daily use	1	2,150.00	13.29		-13.29
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	4 lb/an yr			0.72	+0.72
K_2O	8 lb/an yr			0.80	+0.80
Totals		3,838.00	26.30	2.80	-23.50

[a]Regions: cool, cold, warm and hot humid.

TABLE C-59. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, PARTIAL SLATS, PIT STORAGE (3 MO), LIQUID HANDLING, 20 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	22 hrs		3.85		-3.85
Tractor	2 hrs		0.78		-0.78
Energy	0 kw		0.00		0.00
Concrete floor	40 ft^2/an	1,080.00	6.12		-6.12
Concrete slats	20 ft^2/an	880.00	7.25		-7.25
Concrete pit	40 ft^3/an	230.00	1.30		-1.30
Vacuum tank wagon	1	4,400.00	55.03		-55.03
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	4 lb/an yr			0.72	+0.72
K_2O	8 lb/an yr			0.80	+0.80
Totals		6,590.00	74.34	2.64	-71.70

[a]Regions: cool, cold, warm and hot humid.

TABLE C-60. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, PARTIAL SLATS, PIT STORAGE (3 MO), LIQUID HANDLING, INJECTION, 20 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	23 hrs		4.02		-4.02
Tractor	3 hrs		1.17		-1.17
Energy	0 kw		0.00		0.00
Concrete floor	40 ft^2/an	1,080.00	6.12		-6.12
Concrete slats	20 ft^2/an	880.00	7.25		-7.25
Concrete pit	40 ft^3/an	230.00	1.30		-1.30
Vacuum tank wagon	1	4,400.00	55.03		-55.03
Injector/soil incorp	1	1,400.00	17.51		-17.51
Nutrients					
N	9 lb/an yr			1.44	+1.44
P_2O_5	5 lb/an yr			0.90	+0.90
K_2O	9 lb/an yr			0.90	+0.90
Totals		7,990.00	92.41	3.24	-89.17

[a]Regions: cool, cold, warm and hot humid.

TABLE C-61. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, PARTIAL SLATS, PIT STORAGE (3 MO), LIQUID HANDLING, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	53 hrs		3.71		-3.71
Tractor	3 hrs		0.47		-0.47
Energy	0 kw		0.00		0.00
Concrete floor	40 ft^2/an	2,700.00	6.12		-6.12
Concrete slats	20 ft^2/an	2,200.00	7.25		-7.25
Concrete pit	40 ft^3/an	575.00	1.30		-1.30
Vacuum tank wagon	1	4,400.00	22.01		-22.01
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	4 lb/an yr			0.72	+0.72
K_2O	8 lb/an yr			0.80	+0.80
Totals		9,875.00	40.86	2.64	-38.22

[a] Regions: cool, cold, warm and hot humid.

TABLE C-62. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, PARTIAL SLATS, PIT STORAGE (3 MO), LIQUID HANDLING, INJECTION, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	54 hrs		3.78		-3.78
Tractor	4 hrs		0.63		-0.63
Energy	0 kw		0.00		0.00
Concrete floor	40 ft^2/an	2,700.00	6.12		-6.12
Concrete slats	20 ft^2/an	2,200.00	7.25		-7.25
Concrete pit	40 ft^3/an	575.00	1.30		-1.30
Vacuum tank wagon	1	4,400.00	22.01		-22.01
Injector/soil incorp	1	1,400.00	7.00		-7.00
Nutrients					
N	9 lb/an yr			1.44	+1.44
P_2O_5	5 lb/an yr			0.90	+0.90
K_2O	9 lb/an yr			0.90	+0.90
Totals		11,275.00	48.10	3.24	-44.86

[a] Regions: cool, cold, warm and hot humid.

TABLE C-63. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, PARTIAL SLATS, PIT STORAGE (3 MO), LIQUID HANDLING, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	105 hrs		3.67		-3.67
Tractor	5 hrs		0.39		-0.39
Energy	0 kw		0.00		0.00
Concrete floor	40 ft^2/an	5,400.00	6.12		-6.12
Concrete slats	20 ft^2/an	4,400.00	7.25		-7.25
Concrete pit	40 ft^3/an	1,150.00	1.30		-1.30
Vacuum tank wagon	1	4,400.00	11.01		-11.01
Nutrients					
N	7 lb/an yr			1.12	+1.12
P_2O_5	4 lb/an yr			0.72	+0.72
K_2O	8 lb/an yr			0.80	+0.80
Totals		15,350.00	29.75	2.64	-27.11

[a] Regions: cool, cold, warm and hot humid.

TABLE C-64. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, PARTIAL SLATS, PIT STORAGE (3 MO), LIQUID HANDLING, INJECTION, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	106 hrs		3.71		-3.71
Tractor	6 hrs		0.47		-0.47
Energy	0 kw		0.00		0.00
Concrete floor	40 ft^2/an	5,400.00	6.12		-6.12
Concrete slats	20 ft^2/an	4,400.00	7.25		-7.25
Concrete pit	40 ft^3/an	1,150.00	1.30		-1.30
Vacuum tank wagon	1	4,400.00	11.01		-11.01
Injector/soil incorp	1	1,400.00	3.50		-3.50
Nutrients					
N	9 lb/an yr			1.44	+1.44
P_2O_5	5 lb/an yr			0.90	+0.90
K_2O	9 lb/an yr			0.90	+0.90
Totals		16,750.00	33.37	3.24	-30.13

[a] Regions: cool, cold, warm and hot humid.

TABLE C-65. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, PARTIAL SLATS, SHALLOW PIT, LAGOON, WASTEWATER IRRIGATION, 20 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	2 hrs		0.35		-0.35
Tractor	2 hrs		0.41		-0.41
Energy	0 kw		0.00		0.00
Concrete slats	17.5 ft^2/an	770.00	6.34		-6.34
Concrete pit	13 ft^3/an	80.00	0.45		-0.45
Concrete floor	17.5 ft^2/an	473.00	2.68		-2.68
Lagoon	3,800 ft^3	500.00	3.09		-3.09
Wastewtr irrig/manur	1	2,440.00	30.52		-30.52
Nutrients					
N	2 lb/an yr			0.32	+0.32
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	5 lb/an yr			0.50	+0.50
Totals		4,263.00	43.85	1.18	-42.67

[a] Regions: cold, cool, warm and hot humid.

TABLE C-66. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, PARTIAL SLATS, SHALLOW PIT, LAGOON, WASTEWATER IRRIGATION, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	2 hrs		0.14		-0.14
Tractor	2 hrs		0.16		-0.16
Energy	0 kw		0.00		0.00
Concrete slats	17.5 ft^2/an	1,925.00	6.34		-6.34
Concrete pit	13 ft^3/an	195.00	0.44		-0.44
Concrete floor	17.5 ft^2/an	1,181.00	2.68		-2.68
Lagoon	9,400 ft^3	1,100.00	2.72		-2.72
Wastewtr irrig/manur	1	2,440.00	12.22		-12.22
Nutrients					
N	2 lb/an yr			0.32	+0.32
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	5 lb/an yr			0.50	+0.50
Totals		6,841.00	24.70	1.18	-23.52

[a] Regions: cold, cool, warm, and hot humid.

TABLE C-67. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, PARTIAL SLATS, SHALLOW PIT, LAGOON, WASTEWATER IRRIGATION, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	3 hrs		0.10		-0.10
Tractor	3 hrs		0.12		-0.12
Energy	0 kw		0.00		0.00
Concrete slats	17.5 ft^2/an	3,850.00	6.16		-6.16
Concrete pit	13 ft^3/an	390.00	0.44		-0.44
Concrete floor	17.5 ft^2/an	2,363.00	2.68		-2.68
Lagoon	19,000 ft^3	2,000.00	2.47		-2.47
Wastewtr irrig/manur	1	2,440.00	6.11		-6.11
Nutrients					
N	2 lb/an yr			0.32	+0.32
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	5 lb/an yr			0.50	+0.50
Totals		9,118.00	18.08	1.18	-16.90

[a]Regions:cold, cool, warm, and hot humid.

TABLE C-68. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, PARTIAL SLATS, FLUSH, LAGOON, WASTEWATER IRRIGATION, 20 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	2 hrs		0.35		-0.35
Tractor	2 hrs		0.41		-0.41
Energy	0 kw		0.00		0.00
Concrete floor	17.5 ft^2/an	473.00	2.68		-2.68
Concrete slats	17.5 ft^2/an	770.00	6.34		-6.34
Siphon tank	1	100.00	0.93		-0.93
Concrete pit	13 ft^3/an	80.00	0.41		-0.41
Lagoon	3,000 ft^3	384.00	2.37		-2.37
Recycle pump/pipe	1	500.00	7.72		-7.72
Wastewtr irrig/manur	1	2,440.00	30.52		-30.52
Nutrients					
N	2 lb/an yr			0.32	+0.32
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	5 lb/an yr			0.50	+0.50
Totals		4,747.00	51.74	1.18	-50.56

[a]Regions:cold, cool, warm, and hot humid.

TABLE C-69. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, PARTIAL SLATS, FLUSH, LAGOON, WASTEWATER IRRIGATION, 50 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	2 hrs		0.14		-0.14
Tractor	2 hrs		0.16		-0.16
Energy	0 kw		0.00		0.00
Concrete floor	17.5 ft^2/an	1,181.00	2.68		-2.68
Concrete slats	17.5 ft^2/an	1,925.00	6.34		-6.34
Siphon tank	1	100.00	0.37		-0.37
Concrete pit	13 ft^3/an	195.00	0.45		-0.45
Lagoon	7,900 ft^3	918.00	2.27		-2.27
Recycle pump/pipe	1	600.00	3.71		-3.71
Wastewtr irrig/manur	1	2,440.00	12.21		-12.21
Nutrients					
N	2 lb/an yr			0.32	+0.32
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	5 lb/an yr			0.50	+0.50
Totals		7,359.99	28.33	1.18	-27.15

[a]Regions: cold, cool, warm and hot humid.

TABLE C-70. ECONOMIC DATA FOR SWINE BREEDING, TOTAL SHELTER, PARTIAL SLATS, FLUSH, LAGOON, WASTEWATER IRRIGATION, 100 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	3 hrs		0.10		-0.10
Tractor	3 hrs		0.12		-0.12
Energy	0 kw		0.00		0.00
Concrete floor	17.5 ft^2/an	2,363.00	2.68		-2.68
Concrete slats	17.5 ft^2/an	3,850.00	6.16		-6.16
Siphon tank	2	150.00	0.28		-0.28
Concrete pit	13 ft^3/an	390.00	0.44		-0.44
Lagoon	17,000 ft^3	1,786.00	2.21		-2.21
Recycle pump/pipe	1	750.00	2.32		-2.32
Wastewtr irrig/manur	1	2,440.00	6.11		-6.11
Nutrients					
N	2 lb/an yr			0.32	+0.32
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	5 lb/an yr			0.50	+0.50
Totals		9,804.00	20.42	1.18	-19.24

[a]Regions: cold, cool, warm, and hot humid.

TABLE D-1. ECONOMIC DATA FOR EWES AND LAMBS, UNPAVED LOT, SHELTER, 150 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	30 hrs		0.70		-0.70
Tractor	30 hrs		1.57		-1.57
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	155.00	0.07		-0.07
Concrete floor	20 ft^2/an	1,680.00	1.27		-1.27
Front-end loader	1	2,300.00	2.84		-2.84
Bx spdr/periodic use	1	2,150.00	4.43		-4.43
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	5 lb/an yr			0.90	+0.90
K_2O	13 lb/an yr			1.30	+1.30
Totals		6,285.00	10.88	3.48	-7.40

[a] Regions: cool and cold arid, cool and cold humid.

TABLE D-2. ECONOMIC DATA FOR EWES AND LAMBS, UNPAVED LOT, SHELTER, DETENTION/IRRIGATION, 150 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	33 hrs		0.77		-0.77
Tractor	35 hrs		1.83		-1.83
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	155.00	0.07		-0.07
Concrete floor	20 ft^2/an	1,680.00	1.27		-1.27
Front-end loader	1	2,300.00	2.84		-2.84
Box spdr/periodic use	1	2,150.00	4.43		-4.43
Diversion terrace	160 ft	40.00	0.03		-0.03
Settling basin/earth	225 ft^2	137.00	0.12		-0.12
Detention basin/earth	2250 ft^3	205.00	0.17		-0.17
Wastewater irrig/RO	1	2,440.00	3.18		-3.18
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	5 lb/an yr			0.90	+0.90
K_2O	13 lb/an yr			1.30	+1.30
Totals		9,107.00	14.71	3.48	-11.23

[a] Regions: cool and cold arid, cool and cold humid.

TABLE D-3. ECONOMIC DATA FOR EWES AND LAMBS, UNPAVED LOT, SHELTER, GRASS INFILTRATION, 150 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	30 hrs		0.70		-0.70
Tractor	30 hrs		1.57		-1.57
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	155.00	0.07		-0.07
Concrete floor	20 ft^2/an	1,680.00	1.27		-1.27
Front-end loader	1	2,300.00	2.84		-2.84
Box spdr/periodic use	1	2,150.00	4.43		-4.43
Diversion terrace	160 ft	40.00	0.03		-0.03
Settling basin/earth	225 ft^2	137.00	0.12		-0.12
Infiltration area	8x100 ft	64.00	0.05		-0.05
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	5 lb/an yr			0.90	+0.90
K_2O	13 lb/an yr			1.30	+1.30
Totals		6,526.00	11.08	3.48	-7.60

[a] Regions: cool and cold arid, cool and cold humid

TABLE D-4. ECONOMIC DATA FOR EWES AND LAMBS, UNPAVED LOT, SHELTER, 750 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	110 hrs		0.51		-0.51
Tractor	110 hrs		1.15		-1.15
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	775.00	0.07		-0.07
Concrete floor	20 ft^2/an	8,400.00	1.27		-1.27
Front-end loader	1	2,700.00	0.67		-0.67
Bx spdr/periodic use	1	2,600.00	0.71		-0.71
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	5 lb/an yr			0.90	+0.90
K_2O	13 lb/an yr			1.30	+1.30
Totals		14,475.00	4.38	3.48	-0.90

[a] Regions: cool and cold arid, cool and cold humid.

TABLE D-5. ECONOMIC DATA FOR EWES AND LAMBS, UNPAVED LOT, SHELTER, DETENTION/IRRIGATION, 750 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	121 hrs		0.56		-0.56
Tractor	125 hrs		1.30		-1.30
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	775.00	0.07		-0.07
Concrete floor	20 ft^2/an	8,400.00	1.27		-1.27
Front-end loader	1	2,700.00	0.67		-0.67
Bx spdr/periodic use	1	2,600.00	1.07		-1.07
Diversion terrace	320 ft	80.00	0.01		-0.01
Settling basin/earth	1125 ft^2	353.00	0.07		-0.07
Detention basin/earth	11,250 ft^3	625.00	0.10		-0.10
Wastewater irrig/RO	1	2,440.00	0.64		-0.64
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	5 lb/an yr			0.90	+0.90
K_2O	13 lb/an yr			1.30	+1.30
Totals		17,973,00	5.77	3.48	-2.29

[a] Regions: Cool and cold arid, cool and cold humid.

TABLE D-6. ECONOMIC DATA FOR EWES AND LAMBS, UNPAVED LOT, SHELTER, GRASS INFILTRATION, 750 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	110 hrs		0.51		-0.51
Tractor	110 hrs		1.15		-1.15
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	775.00	0.07		-0.07
Concrete floor	20 ft^2/an	8,400.00	1.27		-1.27
Front-end loader	1	2,700.00	0.67		-0.67
Bx spdr/periodic use	1	2,600.00	0.71		-0.71
Diversion terrace	320 ft	80.00	0.01		-0.01
Settling basin/earth	1125 ft^2	353.00	0.07		-0.07
Infiltration area	9x200 ft	144.00	0.02		-0.02
Nutrients					
N	8 lb/an yr			1.28	+1.28
P_2O_5	5 lb/an yr			0.90	+0.90
K_2O	13 lb/an yr			1.30	+1.30
Totals		15,322.00	4.48	3.48	-1.00

[a] Regions: cool and cold humid, cool and cold arid.

TABLE D-7. ECONOMIC DATA FOR EWES AND LAMBS, UNPAVED LOT, NO SHELTER, 150 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	30 hrs		0.70		-0.70
Tractor	30 hrs		1.52		-1.52
Energy	0 kw		0.00		0.00
Land	45 ft^2/an	233.00	0.11		-0.11
Front-end loader	1	2,300.00	2.84		-2.84
Bx spdr/periodic use	1	2,150.00	4.29		-4.29
Nutrients					
N	6 lb/an yr			0.96	+0.96
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	10 lb/an yr			1.00	+1.00
Totals		12,040.00	9.46	2.50	-6.96

[a] Regions: warm and hot arid.

TABLE D-8. ECONOMIC DATA FOR EWES AND LAMBS, UNPAVED LOT, NO SHELTER, DETENTION/IRRIGATION, 150 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	30 hrs		0.70		-0.70
Tractor	30 hrs		1.52		-1.52
Energy	0 kw		0.00		0.00
Land	45 ft^2/an	233.00	0.11		-0.11
Front-end loader	1	2,300.00	2.84		-2.84
Bx spdr/periodic use	1	2,150.00	4.29		-4.29
Diversion terrace	200 ft	25.00	0.02		-0.02
Settling basin/earth	340 ft^2	145.00	0.10		-0.10
Detention basin/earth	3400 ft^3	230.00	0.18		-0.18
Pump/inject irrig	1	1,500.00	2.00		-2.00
Nutrients					
N	6 lb/an yr			0.96	+0.96
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	10 lb/an yr			1.00	+1.00
Totals		12,040.00	11.76	2.50	-9.26

[a] Regions: warm, hot arid.

TABLE D-9. ECONOMIC DATA FOR EWES AND LAMBS, UNPAVED LOT, NO SHELTER, 750 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	110 hrs		0.51		-0.51
Tractor	110 hrs		0.80		-0.80
Energy	0 kw		0.00		0.00
Land	45 ft^2/an	1,163.00	0.11		-0.11
Front-end loader	1	2,700.00	0.67		-0.67
Bx spdr/periodic use	1	2,150.00	0.86		-0.86
Nutrients					
N	6 lb/an yr			0.96	+0.96
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	10 lb/an yr			1.00	+1.00
Totals		43,250.00	2.95	2.50	-0.45

[a] Regions: warm, hot arid.

TABLE D-10. ECONOMIC DATA FOR EWES AND LAMBS, UNPAVED LOT, NO SHELTER, DETENTION/IRRIGATION, 750 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	110 hrs		0.51		-0.51
Tractor	110 hrs		0.80		-0.80
Energy	0 kw		0.00		0.00
Land	45 ft^2/an	1,163.00	0.11		-0.11
Front-end loader	1	2,700.00	0.67		-0.67
Bx spdr/periodic use	1	2,150.00	0.86		-0.86
Diversion terrace	400 ft	100.00	0.01		-0.01
Settling basin/earth	1700 ft^2	378.00	0.06		-0.06
Detention basin/earth	1700 ft^3	853.00	0.14		-0.14
Pump/inject irrig	1	1,500.00	0.40		-0.40
Nutrients					
N	6 lb/an yr			0.96	+0.96
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	10 lb/an yr			1.00	+1.00
Totals		43,250.00	3.55	2.50	-1.05

[a] Regions: warm, hot arid.

TABLE D-11. ECONOMIC DATA FOR FED LAMBS, PAVED LOT, SHELTER, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	28 hrs		0.49		-0.49
Tractor	28 hrs		1.10		-1.10
Energy	0 kw		0.00		0.00
Concrete lot	6 ft^2/an	1,140.00	0.65		-0.65
Concrete floor	6 ft^2/an	1,620.00	0.92		-0.92
Front-end loader	1	2,300.00	2.13		-2.13
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		7,210.00	7.50	2.14	-5.36

[a]Regions: cool and cold humid.

TABLE D-12. ECONOMIC DATA FOR FED LAMBS, PAVED LOT, SHELTER, GRASS INFILTRATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	28 hrs		0.49		-0.49
Tractor	28 hrs		1.10		-1.10
Energy	0 kw		0.00		0.00
Concrete lot	6 ft^2/an	1,140.00	0.65		-0.65
Concrete floor	6 ft^2/an	1,620.00	0.92		-0.92
Front-end loader	1	2,300.00	2.13		-2.13
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Diversion terrace	100 ft	25.00	0.01		-0.01
Settling basin/earth	230 ft^2	499.00	0.35		-0.35
Infiltration area	12x150 ft	144.00	0.07		-0.07
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		7,878.00	7.94	2.14	-5.80

[a]Regions: cool and cold humid

TABLE D-13. ECONOMIC DATA FOR FED LAMBS, PAVED LOT, SHELTER, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	100 hrs		0.35		-0.35
Tractor	100 hrs		0.78		-0.78
Energy	0 kw		0.00		0.00
Concrete lot	6 ft^2/an	5,700.00	0.65		-0.65
Concrete floor	6 ft^2/an	8,100.00	0.92		-0.92
Front-end loader	1	2,300.00	0.43		-0.43
Bx spdr/periodic use	1	2,600.00	0.54		-0.54
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		18,700.00	3.66	2.14	-1.52

[a] Regions: cool and cold humid.

TABLE D-14. ECONOMIC DATA FOR FED LAMBS, PAVED LOT, SHELTER, GRASS INFILTRATION, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns)$/an yr)	Annual Net System Return ($/an yr)
Labor	100 hrs		0.35		-0.35
Tractor	100 hrs		0.78		-0.78
Energy	0 kw		0.00		0.00
Concrete lot	6 ft^2/an	5,700.00	0.65		-0.65
Concrete floor	6 ft^2/an	8,100.00	0.92		-0.92
Front-end loader	1	2,300.00	0.43		-0.43
Bx spdr/period use	1	2,600.00	0.54		-0.54
Diversion terrace	180 ft	45.00	0.01		-0.01
Settling Basin/earth	300 ft^2	670.00	0.09		-0.09
Infiltration area	12x300 ft	288.00	0.04		-0.04
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		19,703.00	3.79	2.14	-1.65

[a] Regions: cool and cold humid.

TABLE D-15. ECONOMIC DATA FOR FED LAMBS, PAVED LOT, SHELTER, 5000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	207 hrs		0.14		-0.14
Tractor	207 hrs		0.32		-0.32
Energy	0 kw		0.00		0.00
Concrete lot	6 ft^2/an	28,500.00	0.65		-0.65
Concrete floor	6 ft^2/an	40,500.00	0.92		-0.92
Front-end loader	1	2,700.00	0.10		-0.10
Bx spdr/periodic use	1	3,800.00	0.16		-0.16
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		75,500.00	2.29	2.14	-0.15

[a]Regions: cool and cold humid.

TABLE D-16. ECONOMIC DATA FOR FED LAMBS, PAVED LOT, SHELTER, DETENTION/IRRIGATION, 500 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	218 hrs		0.16		-0.16
Tractor	222 hrs		0.35		-0.35
Energy	0 kw		0.00		0.00
Concrete lot	6 ft^2/an	28,500.00	0.65		-0.65
Concrete floor	6 ft^2/an	40,500.00	0.92		-0.92
Front-end loader	1	2,700.00	0.10		-0.10
Bx spdr/periodic use	1	3,800.00	0.16		-0.16
Diversion terrace	360 ft	90.00	0.00		0.00
Settling basin/earth	1500 ft^2	180.00	0.01		-0.01
Detention basin/earth	1500 ft^3	820.00	0.02		-0.02
Wastewater irrig/RO	1	2,890.00	0.11		-0.11
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		79,480.00	2.47	2.14	-0.33

[a]Regions: cool and cold humid.

TABLE D-17. ECONOMIC DATA FOR FED LAMBS, PAVED LOT, SHELTER, GRASS INFILTRATION, 5000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	207 hrs		0.14		-0.14
Tractor	207 hrs		0.32		-0.32
Energy	0 kw		0.00		0.00
Concrete lot	6 ft^2/an	28,500.00	0.65		-0.65
Concrete floor	6 ft^2/an	40,500.00	0.92		-0.92
Front-end loader	1	2,700.00	0.10		-0.10
Bx spdr/periodic use	1	3,800.00	0.16		-0.16
Diversion terrace	380 ft	95.00	0.00		0.00
Settling basin/earth	1500 ft^2	2,445.00	0.07		-0.07
Infiltration area	12x600 ft	576.00	0.01		-0.01
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		78,616.00	2.37	2.14	-0.23

[a] Regions: cool and cold humid.

TABLE D-18. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, SHELTER, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	29 hrs		0.51		-0.51
Tractor	29 hrs		1.14		-1.14
Energy	0 kw		0.00		0.00
Land	20 ft^2/an	138.00	0.08		-0.08
Concrete floor	6 ft^2/an	1,620.00	0.92		-0.92
Front-end loader	1	2,300.00	2.13		-2.13
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		6,208.00	6.98	2.14	-4.84

[a] Regions: cool and cold arid.

TABLD D-19. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, SHELTER, DETENTION/IRRIGATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	32 hrs		0.56		-0.56
Tractor	34 hrs		1.33		-1.33
Energy	0 kw		0.00		0.00
Land	20 ft^2/an	138.00	0.08		-0.08
Concrete floor	6 ft^2/an	1,620.00	0.92		-0.92
Front-end loader	1	2,300.00	2.13		-2.13
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Diversion terrace	160 ft	40.00	0.02		-0.02
Settling basin/earth	200 ft^2	66.00	0.05		-0.05
Detention basin/earth	2000 ft^3	160.00	0.10		-0.10
Wastewater irrig/RO	1	2,440.00	2.39		-2.39
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		8,914.00	9.79	2.14	-7.65

[a]Regions: cool and cold arid.

TABLE D-20. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, SHELTER, GRASS INFILTRATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	29 hrs		0.51		-0.51
Tractor	29 hrs		1.14		-1.14
Energy	0 kw		0.00		0.00
Land	20 ft^2/an	138.00	0.08		-0.08
Concrete floor	6 ft^2/an	1,620.00	0.92		-0.92
Front-end loader	1	2,300.00	2.13		-2.13
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Diversion terrace	160 ft	40.00	0.02		-0.02
Settling basin/earth	200 ft^2	66.00	0.05		-0.05
Infiltration area	12x75 ft	72.00	0.04		-0.04
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		6,386.00	7.10	2.14	-4.96

[a]Regions: cool and cold arid.

TABLE D-21. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, SHELTER, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	103 hrs		0.36		-0.36
Tractor	103 hrs		0.81		-0.81
Energy	0 kw		0.00		0.00
Land	20 ft^2/an	690.00	0.08		-0.08
Concrete floor	6 ft^2/an	8,100.00	0.92		-0.92
Front-end loader	1	2,300.00	0.43		-0.43
Bx spdr/periodic use	1	2,600.00	0.54		-0.54
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		13,690.00	3.12	2.14	-0.98

[a] Regions: Cool and cold arid.

TABLE D-22. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, SHELTER, DETENTION/IRRIGATION, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	114 hrs		0.40		-0.40
Tractor	118 hrs		0.92		-0.92
Energy	0 kw		0.00		0.00
Land	20 ft^2/an	690.00	0.08		-0.08
Concrete floor	6 ft^2/an	8,100.00	0.92		-0.92
Front-end loader	1	2,300.00	0.43		-0.43
Bx spdr/periodic use	1	2,600.00	0.54		-0.54
Diversion terrace	320 ft	80.00	0.01		-0.01
Settling basin/earth	1000 ft^2	195.00	0.03		-0.03
Detention basin/earth	10,000 ft^2	580.00	0.07		-0.07
Wastewater irrig/RO	1	2,890.00	0.57		-0.57
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		17,435.00	3.95	2.14	-1.81

[a] Regions: cool and cold arid.

TABLE D-23. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, SHELTER, GRASS INFILTRATION, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	103 hrs		0.36		-0.36
Tractor	103 hrs		0.81		-0.81
Energy	0 kw		0.00		0.00
Land	20 ft^2/an	690.00	0.08		-0.08
Concrete floor	6 ft^2/an	8,100.00	0.92		-0.92
Front-end loader	1	2,300.00	0.43		-0.43
Bx spdr/period use	1	2,600.00	0.54		-0.54
Diversion terrace	320 ft	80.00	0.01		-0.01
Settling basin/earth	1000 ft^2	195.00	0.03		-0.03
Infiltration area	11x150 ft	132.00	0.02		-0.02
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		14,097.00	3.18	2.14	-1.04

[a]Regions: cool and cold arid.

TABLE D-24. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, SHELTER, 5000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	222 hrs		0.16		-0.16
Tractor	222 hrs		0.35		-0.35
Energy	0 kw		0.00		0.00
Land	20 ft^2/an	3,450.00	0.08		-0.08
Concrete floor	6 ft^2/an	40,500.00	0.92		-0.92
Front-end loader	1	2,700.00	0.10		-0.10
Bx spdr/periodic use	1	3,800.00	0.16		-0.16
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		50,450.00	1.75	2.14	+0.39

[a]Regions: cool and cold arid.

TABLE D-25. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, SHELTER, DETENTION/IRRIGATION, 5000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	272 hrs		0.19		-0.19
Tractor	290 hrs		0.45		-0.45
Energy	0 kw		0.00		0.00
Land	20 ft^2/an	3,450.00	0.08		-0.08
Concrete floor	6 ft^2/an	40,500.00	0.92		-0.92
Front-end loader	1	2,700.00	0.10		-0.10
Bx spdr/periodic use	1	3,800.00	0.16		-0.16
Diversion terrace	680 ft	170.00	0.00		0.00
Settling basin/earth	5,000 ft^2	725.00	0.02		-0.02
Detention basin/earth	50,000 ft^3	1,570.00	0.04		-0.04
Wastewater irrig/RO	1	4,090.00	0.16		-0.16
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		57,005.00	2.12	2.14	+0.02

[a] Regions: cool and cold arid.

TABLE D-26. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, SHELTER, GRASS INFILTRATION, 5000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	222 hrs		0.16		-0.16
Tractor	222 hrs		0.35		-0.35
Energy	0 kw		0.00		0.00
Land	20 ft^2/an	3,450.00	0.08		-0.08
Concrete floor	6 ft^2/an	40,500.00	0.92		-0.92
Front-end loader	1	2,700.00	0.10		-0.10
Bx spdr/periodic use	1	3,800.00	0.16		-0.16
Diversion terrace	680 ft	170.00	0.00		0.00
Settling basin/earth	5000 ft^2	725.00	0.02		-0.02
Infiltration area	12x400 ft	384.00	0.01		-0.01
Nutrients					
N	5 lb/an yr			0.80	+0.80
P_2O_5	3 lb/an yr			0.54	+0.54
K_2O	8 lb/an yr			0.80	+0.80
Totals		51,729.00	1.79	2.14	+0.35

[a] Regions: cool and cold arid.

TABLE D-27. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, NO SHELTER, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	28 hrs		0.49		-0.49
Tractor	28 hrs		1.10		-1.10
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	204.00	0.11		-0.11
Front-end loader	1	2,300.00	2.13		-2.13
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Nutrients					
N	4 lb/an yr			0.64	+0.64
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	5 lb/an yr			0.60	+0.60
Totals		4,852.00	6.04	1.60	-4.44

[a]Regions: warm, hot and cool arid.

TABLE D-28. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, NO SHELTER, DETENTION/IRRIGATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	31 hrs		0.54		-0.54
Tractor	33 hrs		1.29		-1.29
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	204.00	0.11		-0.11
Front-end loader	1	2,300.00	2.13		-2.13
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Diversion terrace	180 ft	45.00	0.03		-0.03
Settling basin/earth	300 ft^2	158.00	0.11		-0.11
Detention basin/earth	3000 ft^3	220.00	0.14		-0.14
Pump/inject irrig	1	1,500.00	1.50		-1.50
Nutrients					
N	4 lb/an yr			0.64	+0.64
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	6 lb/an yr			0.60	+0.60
Totals		5,275.00	8.06	1.60	-6.46

[a]Regions: warm, hot, and cool arid.

TABLE D-29. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, NO SHELTER, GRASS INFILTRATION, 200 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	28 hrs		0.49		-0.49
Tractor	28 hrs		1.10		-1.10
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	204.00	0.11		-0.11
Front-end loader	1	2,300.00	2.13		-2.13
Bx spdr/periodic use	1	2,150.00	2.21		-2.21
Diversion terrace	180 ft	45.00	0.03		-0.03
Settling basin/earth	300 ft^2	158.00	0.11		-0.11
Infiltration area	10x100 ft	80.00	0.05		-0.05
Nutrient					
N	4 lb/an yr			0.64	+0.64
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	6 lb/an yr			0.60	+0.60
Totals		5,135.00	6.23	1.60	-4.63

[a] Regions: cool, warm and hot arid.

D-30. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, NO SHELTER, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	101 hrs		0.35		-0.35
Tractor	101 hrs		0.79		-0.79
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	1,040.00	0.11		-0.11
Front-end loader	1	2,300.00	0.43		-0.43
Bx spdr/periodic use	1	2,600.00	0.54		-0.54
Nutrients					
N	4 lb/an yr			0.64	+0.64
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	6 lb/an yr			0.60	+0.60
Totals		5,940.00	2.22	1.60	-0.62

[a] Regions: cool, warm, hot arid.

TABLE D-31. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, NO SHELTER, DETENTION/IRRIGATION, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	112 hrs		0.39		-0.39
Tractor	116 hrs		0.91		-0.91
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	1,040.00	0.11		-0.11
Front-end loader	1	2,300.00	0.43		-0.43
Bx spdr/periodic use	1	2,600.00	0.54		-0.54
Diversion terrace	360 ft	90.00	0.01		-0.01
Settling basin/earth	1500 ft^2	398.00	0.05		-0.05
Detention basin/earth	15,000 ft^3	740.00	0.09		-0.09
Pump/inject in irrig	1	1,500.00	0.30		-0.30
Nutrients					
N	4 lb/an yr			0.64	+0.64
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	6 lb/an yr			0.60	+0.60
Totals		7,168.00	2.83	1.60	-1.23

[a] Regions: cool, warm, and hot arid.

TABLE D-32. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, NO SHELTER, GRASS INFILTRATION, 1000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	101 hrs		0.35		-0.35
Tractor	101 hrs		0.79		-0.79
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	1,040.00	0.11		-0.11
Front-end loader	1	2,300.00	0.43		-0.43
Bx spdr/periodic use	1	2,600.00	0.54		-0.54
Diversion terrace	160 ft	90.00	0.01		-0.01
Settling basin/earth	1500 ft^2	398.00	0.05		-0.05
Infiltration area	12x200 ft	192.00	0.02		-0.02
Nutrients					
N	4 lb/an yr			0.64	+0.64
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	6 lb/an yr			0.60	+0.60
Totals		6,620.00	2.31	1.60	-0.71

[a] Regions: cool, warm and hot arid.

TABLE D-33. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, NO SHELTER, 5000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	214 hrs		0.15		-0.15
Tractor	214 hrs		0.34		-0.34
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	5,100.00	0.11		-0.11
Front-end loader	1	2,700.00	0.10		-0.10
Bx spdr/periodic use	1	3,800.00	0.16		-0.16
Nutrients					
N	4 lb/an yr			0.64	+0.64
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	6 lb/an yr			0.60	+0.60
Totals		11,600.00	0.85	1.60	+0.75

[a]Regions: cool, warm, hot arid.

TABLE D-34. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, NO SHELTER DETENTION/IRRIGATION, 5000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	264 hrs		0.18		-0.18
Tractor	282 hrs		0.44		-0.44
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	5,100.00	0.11		-0.11
Front-end loader	1	2,700.00	0.10		-0.10
Bx spdr/periodic use	1	3,800.00	0.16		-0.16
Diversion terrace	820 ft	205.00	0.00		0.00
Settling basin/earth	7500 ft^2	1,215.00	0.03		-0.03
Detention basin/earth	75,000 ft^3	2,160.00	0.05		-0.05
Pump/inject in irrig	1	1,500.00	0.06		-0.06
Nutrients					
N	4 lb/an yr			0.64	+0.64
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	6 lb/an yr			0.60	+0.60
Totals		15,180.00	1.13	1.60	+0.47

[a]Regions: cool, warm, hot arid.

TABLE D-35. ECONOMIC DATA FOR FED LAMBS, UNPAVED LOT, NO SHELTER, GRASS INFILTRATION, 5000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	214 hrs		0.15		-0.15
Tractor	214 hrs		0.34		-0.34
Energy	0 kw		0.00		0.00
Land	30 ft^2/an	5,100.00	0.11		-0.11
Front-end loader	1	2,700.00	0.10		-0.10
Bx spdr/periodic use	1	3,800.00	0.16		-0.16
Diversion terrace	820 ft	205.00	0.00		0.00
Settling basin/earth	7500 ft^2	1,215.00	0.03		-0.03
Infiltration area	13x600 ft	624.00	0.02		-0.02
Nutrients					
N	4 lb/an yr			0.64	+0.64
P_2O_5	2 lb/an yr			0.36	+0.36
K_2O	6 lb/an yr			0.60	+0.60
Totals		13,644.00	0.91	1.60	+0.69

[a] Regions: cool, warm, hot arid.

TABLE E-1. ECONOMIC DATA FOR POULTRY, LAYERS, UNDERCAGE STORAGE, TRACTOR SCRAPE, SOLID HANDLING, 10,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	75 hrs		0.03		-0.03
Tractor	23 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Cage scraper/tractoe	1	3,000.00	0.06		-0.06
Concrete floor	0.8 ft^2/an	7,600.00	0.09		-0.09
Trac scraper/loader	1	1,600.00	0.03		-0.03
Box spdr/daily use	1	2,150.00	0.07		-0.07
Nutrients					
N	0.49 lb/an yr			0.08	+0.08
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		14,350.00	0.28	0.28	0.00

[a]Regions: cold, cool, warm, and hot humid, warm arid.

TABLE E-2. ECONOMIC DATA FOR POULTRY, LAYERS, UNDERCAGE STORAGE, TRACTOR SCRAPE, STORAGE (3 MO), SOLID HANDLING, 10,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	25 hrs		0.01		-0.01
Tractor	13 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Cage scraper/tractor	1	3,000.00	0.06		-0.06
Concrete floor	0.8 ft^2/an yr	10,000.00	0.11		-0.11
Trac scraper/loader	1	1,600.00	0.03		-0.03
Box spdr/daily use	1	2,600.00	0.05		-0.05
Nutrients					
N	0.49 lb/an yr			0.08	+0.08
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		17,200.00	0.27	0.28	+0.01

[a]Regions: cold, cool, warm, and hot humid, warm arid.

TABLE E-3. ECONOMIC DATA FOR POULTRY, LAYERS, UNDERCAGE STORAGE, TRACTOR SCRAPE, SOLID HANDLING, 25,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	171 hrs		0.02		-0.02
Tractor	41 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Cage Scraper/tractor	1	3,000.00	0.02		-0.02
Concrete floor	0.8 ft^2/an	19,000.00	0.09		-0.09
Trac scraper/loader	1	1,600.00	0.01		-0.01
Box spdr/daily use	1	2,600.00	0.03		-0.03
Nutrients					
N	0.49 lb/an yr			0.08	+0.08
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		26,200.00	0.19	0.28	+0.09

[a] Regions: cold, cool, warm, and hot humid, warm arid.

TABLE E-4. ECONOMIC DATA FOR POULTRY, LAYERS, UNDERCAGE STORAGE, TRACTOR SCRAPE, STORAGE (3 MO), SOLID HANDLING, 25,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	53 hrs		0.01		-0.01
Tractor	23 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Cage scraper/tractor	1	3,000.00	0.02		-0.02
Concrete floor	0.8 ft^2/an	25,000.00	0.11		-0.11
Trac scraper/loader	1	1,600.00	0.01		-0.01
Box spdr/daily use	1	2,600.00	0.03		-0.02
Nutrients					
N	0.49 lb/an yr			0.08	+0.08
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		32,200.00	0.18	0.28	+0.10

[a] Regions: cold, cool, warm, and hot humid, warm arid.

TABLE E-5. ECONOMIC DATA FOR POULTRY, LAYERS, UNDERCAGE STORAGE, TRACTOR SCRAPE, SOLID HANDLING, 80,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	493 hrs		0.02		-0.02
Tractor	77 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Cage scraper/tractor	1	6,000.00	0.01		-0.01
Concrete floor	0.8 ft^2/an	60,800.00	0.09		-0.09
Trac scraper/loader	1	1,600.00	0.00		0.00
Box spdr/daily use	1	3,800.00	0.01		-0.01
Nutrients					
N	0.49 lb/an yr			0.08	+0.08
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		72,200.00	0.15	0.28	+0.13

[a]Regions: cold, cool, warm, and hot humid, warm arid.

TABLE E-6. ECONOMIC DATA FOR POULTRY, LAYERS, UNDERCAGE STORAGE, TRACTOR SCRAPE, STORAGE (3 MO), SOLID HANDLING, 80,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	138 hrs		0.01		-0.01
Tractor	42 hrs		0.00		0.00
Energy	0 kw		0.00		0.00
Cage scraper/tractor	1	6,000.00	0.02		-0.02
Concrete floor	0.8 ft^2/an	80,000.00	0.11		-0.11
Trac scraper/loader	1	1,600.00	0.00		0.00
Box spdr/daily use	1	3,800.00	0.01		-0.01
Nutrients					
N	0.49 lb/an yr			0.08	+0.08
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		91,400.00	0.15	0.28	+0.13

[a]Regions: Cold, cool, warm, and hot humid, warm arid.

TABLE E-7. ECONOMIC DATA FOR POULTRY, LAYERS, SHALLOW PIT, MECHANICAL SCRAPE, SOLID HANDLING, 10,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	38 hrs		0.01		-0.01
Tractor	23 hrs		0.01		-0.01
Energy	2000 kw		0.01		-0.01
Cage scraper/cable	1	6,000.00	0.15		-0.15
Concrete floor	0.8 ft^2/an	7,600.00	0.09		-0.09
Box spdr/daily use	1	2,150.00	0.07		-0.07
Nutrients					
N	0.49 lb/an yr			0.08	+0.08
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		15,750.00	0.34	0.28	-0.06

[a]Regions: cold, cool, warm, and hot humid, warm arid.

TABLE E-8. ECONOMIC DATA FOR POULTRY, LAYERS, SHALLOW PIT, MECHANICAL SCRAPE, SOLID HANDLING, 25,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Return ($/an yr)	Annual Net System Return ($/an yr)
Labor	71 hrs		0.01		-0.01
Tractor	41 hrs		0.01		-0.01
Energy	5000 kw		0.01		-0.01
Cage scraper/cable	1	12,000.00	0.12		-0.12
Concrete floor	0.8 ft^2/an	19,000.00	0.09		-0.09
Box spdr/daily use	1	2,600.00	0.03		-0.03
Nutrients					
N	0.49 lb/an yr			0.08	+0.08
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		33,600.00	0.27	0.28	+0.01

[a]Regions: cool, cold, warm, and hot humid, warm arid.

TABLE E-9. ECONOMIC DATA FOR POULTRY, LAYERS, SHALLOW PIT, MECHANICAL SCRAPE, SOLID HANDLING, 80,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	233 hrs		0.01		-0.01
Tractor	77 hrs		0.01		-0.01
Energy	16,000 kw		0.01		-0.01
Cage scraper/cable	1	36,000.00	0.11		-0.11
Concrete floor	0.8 ft^2/an	60,800.00	0.09		-0.09
Box spdr/daily use	1	3,800.00	0.01		-0.01
Nutrients					
N	0.49 lb/an yr			0.08	+0.08
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		100,600.00	0.24	0.28	+0.03

[a]Regions: cold, cool, warm, and hot humid, warm arid.

TABLE E-10. ECONOMIC DATA FOR POULTRY, LAYERS, HIGH RISE BUILDING, TRACTOR LOADER, SOLID HANDLING, 10,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	23 hrs		0.01		-0.01
Tractor	23 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Concrete pit	1	7,060.00	0.08		-0.08
Concrete floor	0.38 ft^2/an	3,610.00	0.04		-0.04
Bx spdr/periodic use	1	2,150.00	0.04		-0.04
Trac scraper/loader	1	2,300.00	0.04		-0.04
Nutrients					
N	0.52 lb/an yr			0.08	+0.08
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		15,120.00	0.23	0.28	+0.05

[a]Regions: cool humid, warm humid, warm arid.

TABLE E-11. ECONOMIC DATA FOR POULTRY, LAYERS, HIGH RISE BUILDING, TRACTOR LOADER, SOLID HANDLING, PLOWDOWN, 10,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	23 hrs		0.01		-0.01
Tractor	23 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Concrete pit	2.4 ft^3/an	7,060.00	0.08		-0.08
Concrete floor	0.38 ft^2/an	3,610.00	0.04		-0.04
Bx spdr/periodic use	1	2,150.00	0.04		-0.04
Trac scraper/loader	1	2,300.00	0.04		-0.04
Nutrients					
N	0.63 lb/an yr			0.10	+0.10
P_2O_5	0.86 lb/an yr			0.15	+0.15
K_2O	0.50 lb/an yr			0.05	+0.05
Totals		15,120.00	0.23	0.31	+0.08

[a]Regions: cool humid, warm humid, warm arid.

TABLE E-12. ECONOMIC DATA FOR POULTRY, LAYERS, HIGH RISE BUILDING, TRACTOR LOADER, SOLID HANDLING, 25,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	40 hrs		0.01		-0.01
Tractor	40 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Concrete pit	2.4 ft^3/an	17,600.00	0.08		-0.08
Concrete floor	0.38 ft^2/an	9,025.00	0.06		-0.06
Bx spdr/periodic use	1	2,600.00	0.02		-0.02
Trac Scraper/loader	1	2,300.00	0.02		-0.02
Nutrients					
N	0.52 lb/an yr			0.08	+0.08
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		31,525.00	0.20	0.28	+0.08

[a]Regions: cool humid, warm humid, warm arid.

TABLE E-13. ECONOMIC DATA FOR POULTRY, LAYERS, HIGH RISE BUILDING, TRACTOR LOADER, SOLID HANDLING, PLOWDOWN, 25,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	40 hrs		0.01		-0.01
Tractor	40 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Concrete pit	2.4 ft^3/an	17,600.00	0.08		-0.08
Concrete floor	0.38 ft^2/an	9,025.00	0.04		-0.04
Bx spdr/periodic use	1	2,600.00	0.02		-0.02
Trac scraper/loader	1	2,300.00	0.02		-0.02
Nutrients					
N	0.63 lb/an yr			0.10	+0.10
P_2O_5	0.86 lb/an yr			0.15	+0.15
K_2O	0.50 lb/an yr			0.05	+0.05
Totals		31,525.00	0.17	0.31	+0.13

[a] Regions: cool humid, warm humid, warm arid.

TABLE E-14. ECONOMIC DATA FOR POULTRY, LAYERS, HIGH RISE BUILDING, TRACTOR LOADER, SOLID HANDLING, 80,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	73 hrs		0.00		0.00
Tractor	73 hrs		0.00		0.00
Energy	0 kw		0.00		0.00
Concrete pit	2.4 ft^3/an	56,430.00	0.08		-0.08
Concrete floor	0.38 ft^2/an	28,880.00	0.04		-0.04
Bx spdr/periodic use	1	3,800.00	0.01		-0.01
Trac scraper/loader	1	2,300.00	0.01		-0.01
Nutrients					
N	0.52 lb/an yr			0.08	+0.08
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		91,410.00	0.14	0.28	+0.14

[a] Regions: cool humid, warm humid, warm arid.

TABLE E-15. ECONOMIC DATA FOR POULTRY, LAYERS, HIGH RISE BUILDING, TRACTOR LOADER, SOLID HANDLING, PLOWDOWN, 80,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	73 hrs		0.00		0.00
Tractor	73 hrs		0.00		0.00
Energy	0 kw		0.00		0.00
Concrete pit	2.4 ft^3/an	56,430.00	0.08		-0.08
Concrete floor	0.38 ft^2/an	28,880.00	0.04		-0.04
Bx spdr/periodic use	1	3,800.00	0.01		-0.01
Trac scraper/loader	1	2,300.00	0.01		-0.01
Nutrients					
N	0.63 lb/an yr			0.10	+0.10
P_2O_5	0.86 lb/an yr			0.15	+0.15
K_2O	0.50 lb/an yr			0.05	+0.05
Totals		91,410.00	0.14	0.31	+0.16

[a]Regions: cool humid, warm humid, warm arid.

TABLE E-16. ECONOMIC DATA FOR POULTRY, LAYERS, FLUSH SHALLOW PIT TO STORAGE BASIN, PUMP TO IRRIGATION SYSTEM, 10,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	5 hrs		0.00		0.00
Tractor	11 hrs		0.01		-0.01
Energy	5,000 kw		0.03		-0.03
Concrete floor	0.8 ft^2/an	7,600.00	0.09		-0.09
Recycle pump/pipe	1	2,400.00	0.07		-0.07
Storage basin	31,500 ft^3	1,290.00	0.02		-0.02
Wastewtr irrig/manur	1	3,000.00	0.08		-0.08
Nutrients					
N	0.58 lb/an yr			0.09	+0.09
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		14,290.00	0.29	0.29	0.00

[a]Regions: warm arid.

TABLE E-17. ECONOMIC DATA FOR POULTRY, LAYERS, FLUSH SHALLOW PIT TO STORAGE BASIN, PUMP TO IRRIGATION SYSTEM, 25,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	5 hrs		0.00		0.00
Tractor	10 hrs		0.00		0.00
Energy	10,000 kw		0.02		-0.02
Concrete floor	0.8 ft^2/an	19,000.00	0.09		-0.09
Gated tank	8	4,000.00	0.03		-0.03
Recycle pump/pipe	1	1,000.00	0.01		-0.01
Storage basin	80,000 ft^3	2,740.00	0.01		-0.01
Wastewtr irrig/manur	1	3,000.00	0.03		-0.03
Nutrients					
N	0.58 lb/an yr			0.09	+0.09
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		29,740.00	0.20	0.29	+0.09

[a]Regions: warm arid.

TABLE E-18. ECONOMIC DATA FOR POULTRY, LAYERS, FLUSH SHALLOW PIT TO STORAGE BASIN, PUMP TO IRRIGATION SYSTEM, 80,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	28 hrs		0.00		0.00
Tractor	56 hrs		0.01		-0.01
Energy	30,000 kw		0.02		-0.02
Concrete floor	0.8 ft^2/an	60,800.00	0.09		-0.09
Gated tank	24	12,000.00	0.03		-0.03
Recycle pump/pipe	1	3,000.00	0.01		-0.01
Storage basin	250,000 ft^3	7,540.00	0.01		-0.01
Wastewtr irrig/manur	1	4,400.00	0.01		-0.01
Nutrients					
N	0.58 lb/an yr			0.09	+0.09
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		87.740.00	0.18	0.29	+0.11

[a]Regions: warm arid.

TABLE E-19. ECONOMIC DATA FOR POULTRY, LAYERS, FLUSH SHALLOW PIT TO LAGOON, WASTEWATER DISPOSAL, 10,000 ANIMAL UNITS[a]

Components	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Leabor	56 hrs		0.02		-0.02
Tractor	72 hrs		0.04		-0.04
Energy	5,000 kw		0.03		-0.03
Concrete floor	0.8 ft^2/an	7,600.00	0.09		-0.09
Recycle pump/pipe	1	2,400.00	0.07		-0.07
Lagoon	300,000 ft^3	9,100.00	0.11		-0.11
Wastewtr irrig/manur	1	3,090.00	0.08		-0.08
Nutrients					
N	0.16 lb/an yr			0.03	+0.03
P_2O_5	0.46 lb/an yr			0.08	+0.08
K_2O	0.32 lb/an yr			0.03	+0.03
Totals		22,190.00	0.43	0.14	-0.29

[a] Regions: warm humid, hot humid.

TABLE E-20. ECONOMIC DATA FOR POULTRY, LAYERS, FLUSH SHALLOW PIT TO LAGOON, WASTEWATER DISPOSAL, 25,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	120 hrs		0.02		-0.02
Tractor	180 hrs		0.04		-0.04
Energy	10,000 kw		0.02		-0.02
Concrete floor	0.8 ft^2/an	19,000.00	0.09		-0.09
Recycle pump/pipe	1	2,900.00	0.04		-0.04
Lagoon	750,000 ft^3	21,500.00	0.11		-0.11
Wastewtr irrig/manur	1	3,690.00	0.04		-0.04
Nutrients					
N	0.16 lb/an yr			0.03	+0.03
P_2O_5	0.46 lb/an yr			0.08	+0.08
K_2O	0.32 lb/an yr			0.03	+0.03
Totals		47,090.00	0.34	0.14	-0.20

[a] Regions: warm humid, hot humid.

TABLE E-21. ECONOMIC DATA FOR POULTRY, LAYERS, FLUSH SHALLOW PIT TO LAGOON, WASTEWATER DISPOSAL, 80,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Return ($/an yr)	Annual Net System Return ($/an yr)
Labor	480 hrs		0.02		-0.02
Tractor	720 hrs		0.07		-0.07
Energy	30,000 kw		0.02		-0.02
Concrete floor	0.8 ft^2/an	60,800.00	0.09		-0.09
Recycle pump/pipe	2	6,800.00	0.03		-0.03
Lagoon	2.4×10^6 ft^3	50,000.00	0.08		-0.08
Wastewtr irrig/manur	1	6,600.00	0.02		-0.02
Nutrients					
N	0.16 lb/an yr			0.03	+0.03
P_2O_5	0.46 lb/an yr			0.08	+0.08
K_2O	0.32 lb/an yr			0.03	+0.03
Totals		124,200.00	0.32	0.14	-0.18

[a] Regions: warm humid, hot humid.

TABLE E-22. ECONOMIC DATA FOR POULTRY, BROILERS, LITTER, SOLID HANDLING, 25,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	30 hrs		0.00		0.00
Tractor	30 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Concrete floor	0.9 ft^2/an	21,375.00	0.10		-0.10
Trac scraper/loader	1	2,300.00	0.02		-0.02
Bx spdr/periodic use	1	2,150.00	0.02		-0.02
Bedding	0.16 ft^3/an yr	0.00	0.03		-0.03
Nutrients					
N	0.35 lb/an yr			0.06	+0.06
P_2O_5	0.41 lb/an yr			0.07	+0.07
K_2O	0.30 lb/an yr			0.03	+0.03
Totals		25,825.00	0.17	0.16	-0.01

[a] Regions: warm humid, hot humid, warm arid.

TABLE E-23. ECONOMIC DATA FOR POULTRY, BROILERS, LITTER, SOLID HANDLING, PLOWDOWN, 25,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	30 hrs		0.00		0.00
Tractor	30 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Concrete floor	0.9 ft^2/an	21,375.00	0.10		-0.10
Trac scraper/loader	1	2,300.00	0.02		-0.02
Bx spdr/periodic use	1	2,150.00	0.02		-0.02
Bedding	0.16 ft^3/an yr	0.00	0.03		-0.03
Nutrients					
N	0.42 lb/an yr			0.07	+0.07
P_2O_5	0.43 lb/an yr			0.08	+0.08
K_2O	0.31 lb/an yr			0.03	+0.03
Totals		25,825.00	0.17	0.18	+0.01

[a] Regions: warm humid, hot humid, warm arid.

TABLE E-24. ECONOMIC DATA FOR POULTRY, BROILERS, LITTER, SOLID HANDLING, 80,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	65 hrs		0.00		0.00
Tractor	65 hrs		0.00		0.00
Energy	0 kw		0.00		0.00
Concrete floor	0.9 ft^2/an	68,400.00	0.10		-0.10
Trac scraper/loader	1	2,300.00	0.01		-0.01
Bx spdr/periodic use	1	2,600.00	0.01		-0.01
Bedding	0.16 ft^3/an yr	0.00	0.03		-0.03
Nutrients					
N	0.35 lb/an yr			0.06	+0.06
P_2O_5	0.41 lb/an yr			0.07	+0.07
K_2O	0.30 lb/an yr			0.03	+0.03
Totals		73,300.00	0.15	0.16	+0.01

[a] Regions: warm humid, hot humid, warm arid.

TABLE E-25. ECONOMIC DATA FOR POULTRY, BROILERS, LITTER, SOLID HANDLING, PLOWDOWN, 80,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	65 hrs		0.00		0.00
Tractor	65 hrs		0.00		0.00
Energy	0 kw		0.00		0.00
Concrete floor	0.9 ft^2/an	68,400.00	0.10		-0.10
Trac scraper/loader	1	2,300.00	0.01		-0.01
Bx spdr /periodic use	1	2,600.00	0.01		-0.01
Bedding	0.16 ft^3/an yr	0.00	0.03		-0.03
Nutrients					
N	0.42 lb/an yr			0.07	+0.07
P_2O_5	0.43 lb/an yr			0.08	+0.08
K_2O	0.31 lb/an yr			0.03	+0.03
Totals		73,300.00	0.15	0.18	+0.03

[a] Regions: warm humid, hot humid, warm arid.

TABLE E-26. ECONOMIC DATA FOR POULTRY, CHICKEN/BROODING, LITTER, SOLID HANDLING, 6,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	37 hrs		0.02		-0.02
Tractor	37 hrs		0.03		-0.03
Energy	0 kw		0.00		0.00
Concrete floor	2 ft^2/an	11,400.00	0.22		-0.22
Trac scraper/loader	1	2,300.00	0.07		-0.07
Bx spdr/periodic use	1	2,150.00	0.07		-0.07
Bedding	0.3 ft^3/an yr	0.00	0.06		-0.06
Nutrients					
N	0.42 lb/an yr			0.07	+0.07
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		15,850.00	0.47	0.26	-0.21

[a] Regions: warm humid, hot humid, cold humid, warm arid, cool humid.

TABLE E-27. ECONOMIC DATA FOR POULTRY, CHICKEN/BROODING, LITTER, SOLID HANDLING, 12,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	74 hrs		0.02		-0.02
Tractor	74 hrs		0.03		-0.03
Energy	0 kw		0.00		0.00
Concrete floor	2 ft^2/an	22,800.00	0.22		-0.22
Trac scraper/loader	1	2,300.00	0.04		-0.04
Bx spdr/periodic use	1	2,150.00	0.04		-0.04
Bedding	0.3 ft^3/an yr	0.00	0.06		-0.06
Nutrients					
N	0.42 lb/an yr			0.07	+0.07
P_2O_5	0.82 lb/an yr			0.15	+0.15
K_2O	0.48 lb/an yr			0.05	+0.05
Totals		27,250.00	0.40	0.26	-0.14

[a]Regions: warm humid, hot humid, cold humid, warm arid, cool humid.

TABLE E-28. ECONOMIC DATA FOR POULTRY, TURKEY/BROODING, SOLID HANDLING, 3,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	36 hrs		0.04		-0.04
Tractor	36 hrs		0.07		-0.07
Energy	0 kw		0.00		0.00
Concrete floor	3 ft^2/an	8,550.00	0.32		-0.32
Trac scraper/loader	1	2,300.00	0.14		-0.14
Bx spdr/periodic use	1	2,150.00	0.15		-0.15
Bedding	0.5 ft^3/an yr	0.00	0.10		-0.10
Nutrients					
N	0.84 lb/an yr			0.13	+0.13
P_2O_5	1.64 lb/an yr			0.30	+0.30
K_2O	0.96 lb/an yr			0.10	+0.10
Totals		13,000.00	0.82	0.53	-0.29

[a]Regions: warm humid, hot humid, cold humid, warm arid, cool humid.

TABLE E-29. ECONOMIC DATA FOR POULTRY, TURKEY/BROODING, SOLID HANDLING, 6000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	72 hrs		0.04		-0.04
Tractor	72 hrs		0.07		-0.07
Energy	0 kw		0.00		0.00
Concrete floor	3 ft^2/an	17,100.00	0.32		-0.32
Trac scraper/loader	1	2,300.00	0.07		-0.07
Bx spdr /periodic use	1	2,150.00	0.07		-0.07
Bedding	0.5 ft^3/an yr	0.00	0.10		-0.10
Nutrients					
N	0.84 lb/an yr			0.13	+0.13
P_2O_5	1.64 lb/an yr			0.30	+0.30
K_2O	0.96 lb/an yr			0.10	+0.10
Totals		21,550.00	0.67	0.53	-0.15

[a]Regions: warm humid, hot humid, cold humid, warm arid, cool humid.

TABLE E-30. ECONOMIC DATA FOR POULTRY, TURKEY, LITTER, SOLID HANDLING, 10,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	43 hrs		0.02		-0.02
Tractor	43 hrs		0.02		-0.02
Energy	0 kw		0.00		0.00
Concrete floor	3 ft^2/an	28,500.00	0.32		-0.32
Trac scraper/loader	1	2,300.00	0.04		-0.04
Bx spdr/periodic use	1	2,150.00	0.04		-0.04
Bedding	0.21 ft^3/an yr	0.00	0.04		-0.04
Nutrients					
N	1.0 lb/an yr			0.16	+0.16
P_2O_5	1.4 lb/an yr			0.25	+0.25
K_2O	1.4 lb/an yr			0.14	+0.14
Totals		32,950.00	0.49	0.55	+0.07

[a]Regions: warm humid, hot humid, cold humid, warm arid, cool humid.

TABLE E-31. ECONOMIC DATA FOR POULTRY, TURKEY, LITTER, SOLID HANDLING PLOWDOWN, 10,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	75 hrs		0.02		-0.02
Tractor	75 hrs		0.02		-0.02
Energy	0 kw		0.00		0.00
Concrete floor	3 ft^2/an	28,500.00	0.32		-0.32
Trac scraper/loader	1	2,300.00	0.04		-0.04
Bx spdr/periodic use	1	2,150.00	0.04		-0.04
Bedding	0.21 ft^3/an yr	0.00	0.04		-0.04
Nutrients					
N	1.2 lb/an yr			0.19	+0.19
P_2O_5	1.5 lb/an yr			0.27	+0.27
K_2O	1.4 lb/an yr			0.14	+0.14
Totals		32,950.00	0.49	0.60	+0.12

[a] Regions: warm humid, hot humid, cold humid, warm arid, cool humid.

TABLE E-32. ECONOMIC DATA FOR POULTRY, TURKEY, LITTER, SOLID HANDLING 25,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	75 hrs		0.01		-0.01
Tractor	75 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Concrete floor	3 ft^2/an	71,250.00	0.32		-0.32
Trac scraper/loader	1	2,300.00	0.02		-0.02
Bx spdr/periodic use	1	2,600.00	0.02		-0.02
Bedding	0.21 ft^3/an yr	0.00	0.04		-0.04
Nutrients					
N	1.0 lb/an yr			0.16	+0.16
P_2O_5	1.4 lb/an yr			0.25	+0.25
K_2O	1.4 lb/an yr			0.14	+0.14
Totals		76,150.00	0.43	0.55	+0.12

[a] Regions: warm humid, hot humid, cold humid, warm arid, cool humid.

TABLE E-33. ECONOMIC DATA FOR POULTRY, TURKEY, LITTER, SOLID HANDLING PLOWDOWN, 25,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Return ($/an yr)	Annual Net System Return ($/an yr)
Labor	75 hrs		0.01		-0.01
Tractor	75 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Concrete floor	3 ft^2/an	71,250.00	0.32		-0.32
Trac scraper/loader	1	2,300.00	0.02		-0.02
Bx spdr /periodic use	1	2,600.00	0.02		-0.02
Bedding	0.21 ft^3/an yr	0.00	0.04		-0.04
Nutrients					
N	1.2 lb/an yr			0.19	+0.19
P_2O_5	1.5 lb/an yr			0.27	+0.27
K_2O	1.4 lb/an yr			0.14	+0.14
Totals		76,150.00	0.43	0.60	+0.17

[a] Regions: Warm humid, hot humid, cold humid, warm arid, cool humid.

TABLE E-34. ECONOMIC DATA FOR POULTRY, TURKEY, VEGETATED LOT, 10,000 ANIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	0 hrs		0.00		0.00
Tractor	0 hrs		0.00		0.00
Energy	0 kw		0.00		0.00
Land	750 an/acre	16,000.00	0.18		-0.18
Nutrients					
N	0			0.00	0.00
P_2O_5	0			0.00	0.00
K_2O	0			0.00	0.00
Totals		16,000.00	0.18	0.00	-0.18

[a] Regions: cold, cool, warm and hot humid, warm arid.

TABLE E-35. ECONOMIC DATA FOR POULTRY, VEGETATED LOT, REDUCED STOCKING, MOVED WEEKLY, 10,000 ENIMAL UNITS[a]

Component	Quantity	Capital Investment ($)	Annual Cost ($/an yr)	Annual Returns ($/an yr)	Annual Net System Return ($/an yr)
Labor	0 hrs		0.01		-0.01
Tractor	0 hrs		0.01		-0.01
Energy	0 kw		0.00		0.00
Land	250 an/acre	48,000.00	0.53		-0.53
Nutrients					
N	0			0.00	0.00
P_2O_5	0			0.00	0.00
K_2O	0			0.00	0.00
Totals		48,000.00	0.55	0.00	-0.55

[a] Regions: cold humid.

APPENDIX F

ENGLISH TO METRIC CONVERSION

To Convert From	To	Multiply by
acre (AC)	hectare	0.404
square foot (ft^2)	metre^2 (m^2)	0.093
foot (ft)	metre (m)	0.304
inch (in)	centimetre (cm)	2.540
pound (lb)	kilogram (kg)	0.454
kilowatt (kw)	watt (w)	1000
ton (2000 lb)	kg	907

GLOSSARY OF TERMS

Agitation: The turbulent mixing of liquid and solids. Agitation is necessary to remove settled solids from manure storage.

Agricultural Wastes: Wastes normally associated with the production and processing of food and fiber on farms, feedlots, ranches, ranges, and forests which may include animal manure, crop residues, and dead animals; also, agricultural chemicals, fertilizers and pesticides, which may find their way into the soil and subsequently into the surface and subsurface water.

Composting: Biological degradation of organic matter to a relatively stable humus-like material called compost. Usually this is an aerobic semi-dry process, but may be anaerobic.

Dehydration: The chemical or physical process whereby water in chemical or physical combination with other matter is removed.

Detention Pond: An earth structure constructed to store runoff water and other wastewater until such time as the liquid may be recycled onto land. Sometimes called holding ponds.

Earth Manure Storage Basin: An earth basin constructed to store liquid or semi-solid manure.

Effluent: Wastewater or other liquid, treated or untreated, flowing from reservoir, basin, treatment plant, or part thereof.

Flushing Channel (gutter): A shallow trough (normally 2-5 inches deep), wide enough for livestock to stand in it, into which water is discharged for the purpose of hydraulicly transporting accumulated manure to storage or treatment.

Grassed Infiltration Area: An area with vegetative cover where runoff water infiltrates into the soil.

Holding Pond: See Detention Pond.

Infiltration: The process whereby a liquid enters the soil or other filtering medium.

Influent: Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment plant, or any unit thereof.

Lagoon: An earth structure for the biological treatment for liquid organic wastes. Lagoons can be aerobic, anaerobic, or facultative depending on their loading and design, and can be used in series to produce a higher quality effluent.

Liquid Manure: A mixture of water and manure which can be pumped. It is usually less than 15% solids.

Litter: The bedding material used for poultry and livestock.

Livestock Waste: A term cometimes applied to manure which may contain such matter as bedding, water and soil. It also includes wastes such as milking center or washing wastes not particularly associated with manure, and includes hair, feathers, and other debris.

Manure: The fecal and urinary excretions of livestock and poultry. Manure may also contain some spilled feed and water, bedding or litter, and is often referred to as animal or livestock waste.

Manure Storage: A storage unit and/or management practice to keep manure contained for some period of time prior to its ultimate disposal. Manure storages are usually classified by type and form of manure stored and/or construction of the storage; i.e., concrete liquid manure tank, earth storage basin, solid manure storage, plank walled storage.

Manure Tank: A storage unit in which accumulations of manure are collected before subsequent handling or treatment, or both, and ultimate utilization or disposal. Water may be added in the tank to promote liquefaction.

Odor Nuisance: That condition where odors emanating from a facility, continuously and unreasonably interfere with a person's (neighbor's) enjoyment of his land.

Oxidation Ditch: A modified form of the activated sludge process. An aeration device supplies oxygen and circulates the liquid in a looped open channel ditch.

Porous Dam: A runoff control structure which reduces the flow of runoff so the solids settle out in the settling terrace or settling basin. It may consist of such things as rock, expanded metal, narrow wood slot, etc.

Settling Basin: A concrete or earth bottomed settling structure where the solids in runoff settle out.

Settleable Solids: That matter in wastewater which will not stay in suspension during a preselected settling period, such as one hour.

Slotted Floor: The floor surface of a building which has open spaces or grooves to allow manure and other waste material to pass through the floor.

Solid Manure: A mixture of manure and bedding which cannot be pumped. It is normally more than 15% solids.

Solid Manure Storage: A storage unit in which accumulations of manure with or without bedding are collected before subsequent handling or treatment or both, and ultimate utilization or disposal. The liquid portion including urine and precipitation may or may not be drained from the unit. Sometimes called a manure stack.

Solids Content: (1) The residue remaining when the water is evaporated away from a sample of water, sewage, other liquids, or semi-solid masses of material and the residue is then dried at a specified temperature (usually 103°C for 24 hours); usually stated in milligrams per liter or percent solids. (2) It is the sum of the dissolved and suspended constituent in water or wastewater.

Supernatant: The liquid standing above a sediment or precipitate after settling of centrifuging.

Suspended Solids: Solids that are in water, wastewater, or other liquids, and which are largely removable by laboratory filtering.

Wastewater: Water that contains agricultural wastes generated by production facilities which must be disposed of in a non-polluting manner.

Wastewater Irrigation: A process using a sprinkler, flooding or overland flow method of applying rainfall runoff, lagoon effluent, manure slurry, agricultural process wastewater as other wastewaters to land.